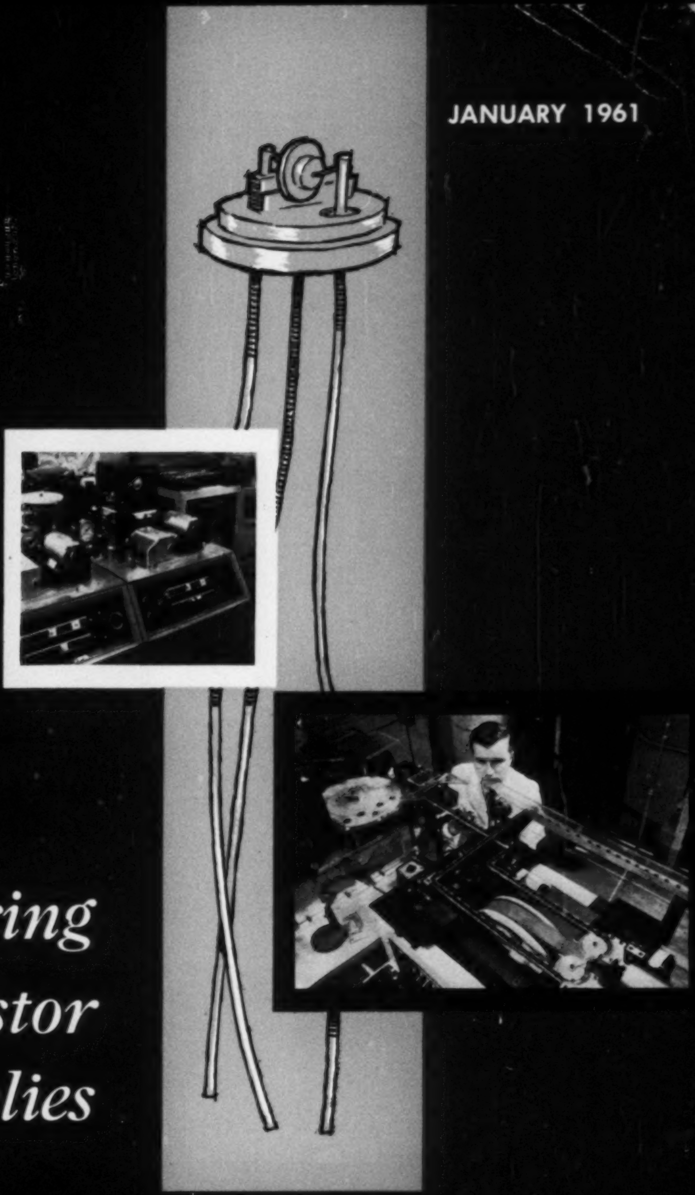
AUTOMATION

JANUARY 1961



Producing Transistor Assemblies

THE MAGAZINE OF AUTOMATIC MANUFACTURING OPERATIONS

Ed Weiner, president, talks with Ed Lebowitz, right, Chesterfield's superintendent, by one of the firm's three Wean Equipment slitting lines.

Chesterfield Steel relies on speed, accuracy, durability of Wean coil processing lines

Fast delivery—when, where, and how the customer wants it—is the metal warehouse's stock-in-trade. And Ed Weiner, president of Cleveland's Chesterfield Steel Service Co., is proud of the firm's record for on-time, "on-spec" deliveries of strip and sheet steel, nonferrous and coated metals.

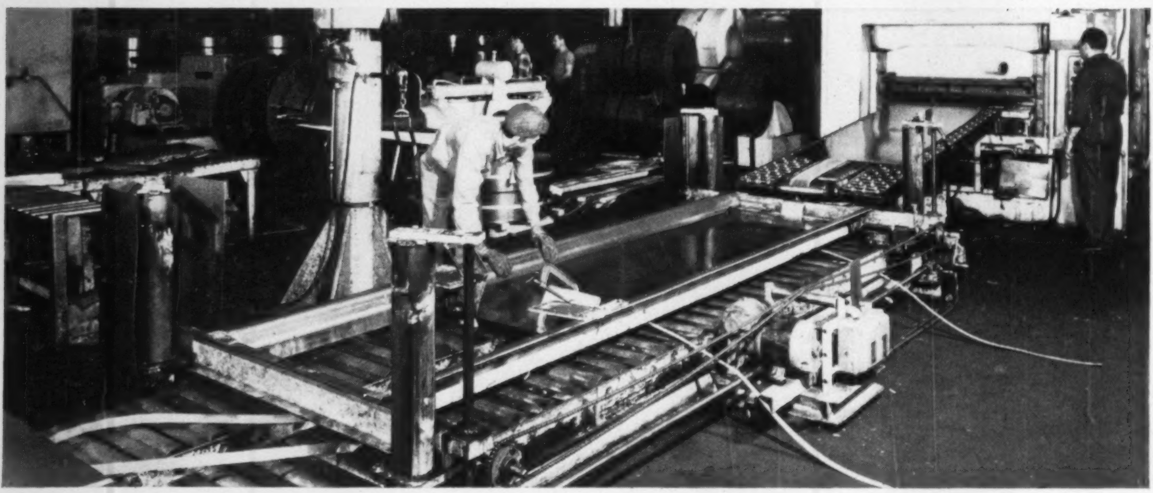
To maintain this reputation for service, Chesterfield needs equipment that will maintain its accuracy under tough, 3-shift, week-long operation. That's why this progressive firm has installed three Wean slitting lines and the 52″ Wean flying shear line shown below . . . and is ordering another flying shear line for 60″ wide strip. Most of the firm's orders for sheet material pass through this coil processing equipment, making both speed and reliability of operation vital. Mr. Weiner notes that the Wean 52″ flying shear line has doubled sheet production over other types of lines previously used by Chesterfield.

Like Chesterfield, Wean has established a reputation as one of the most knowledgeable firms in the field of coil processing and has built equipment that is now serving many of the country's largest metalworking firms. Write for a brochure covering the important savings *you* can realize from coil processing.

WEAN EQUIPMENT CORPORATION
22800 Lakeland Boulevard
CLEVELAND 17, OHIO

WEAN

Wean flying shear line has elevating run-out conveyor and side guides which adapt to pack height.



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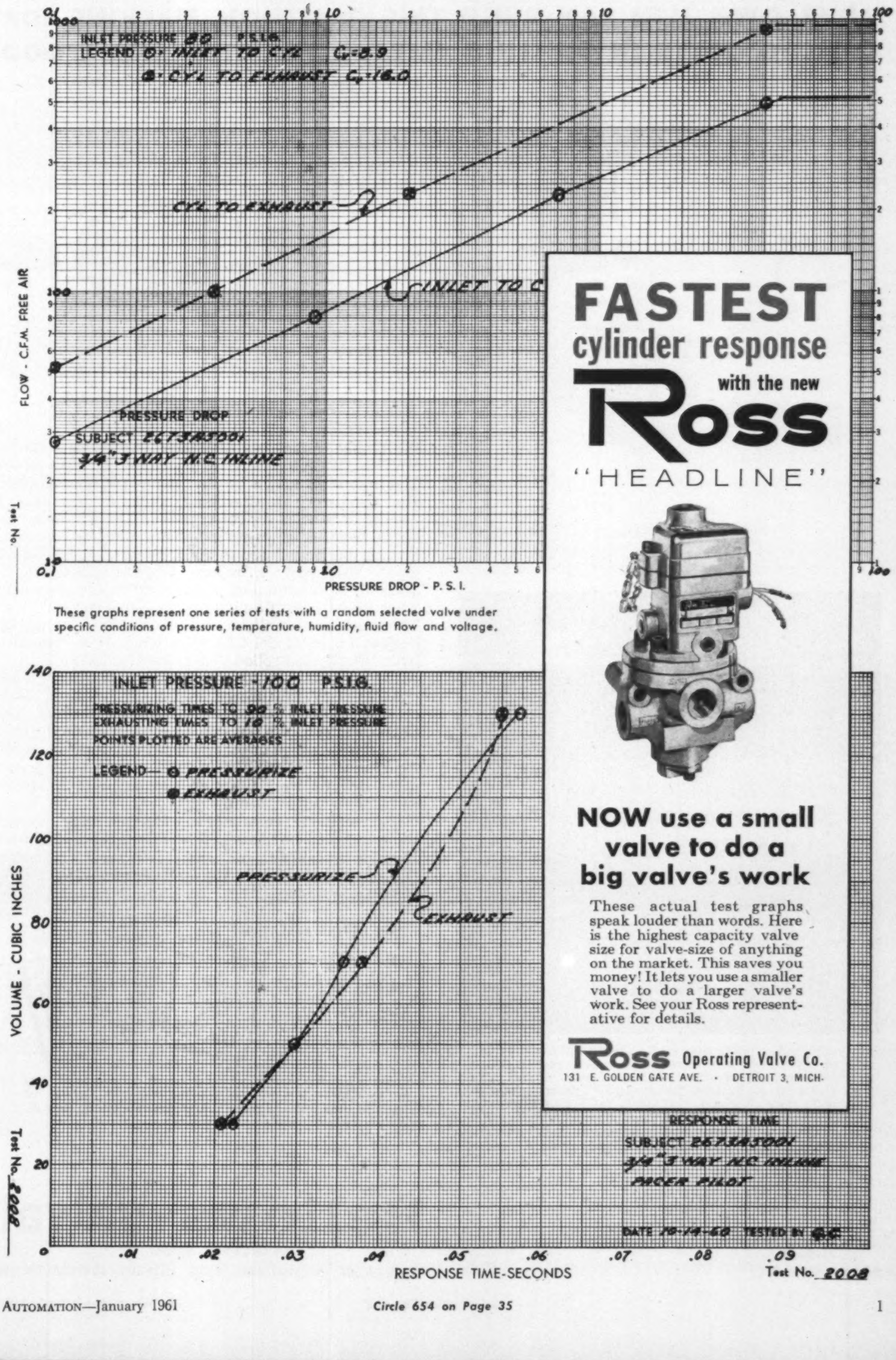

These graphs represent one series of tests with a random selected valve under specific conditions of pressure, temperature, humidity, fluid flow and voltage.

FASTEST
cylinder response
with the new
Ross
"HEADLINE"

NOW use a small valve to do a big valve's work

These actual test graphs speak louder than words. Here is the highest capacity valve size for valve-size of anything on the market. This saves you money! It lets you use a smaller valve to do a larger valve's work. See your Ross representative for details.

Ross Operating Valve Co.
131 E. GOLDEN GATE AVE. · DETROIT 3, MICH.

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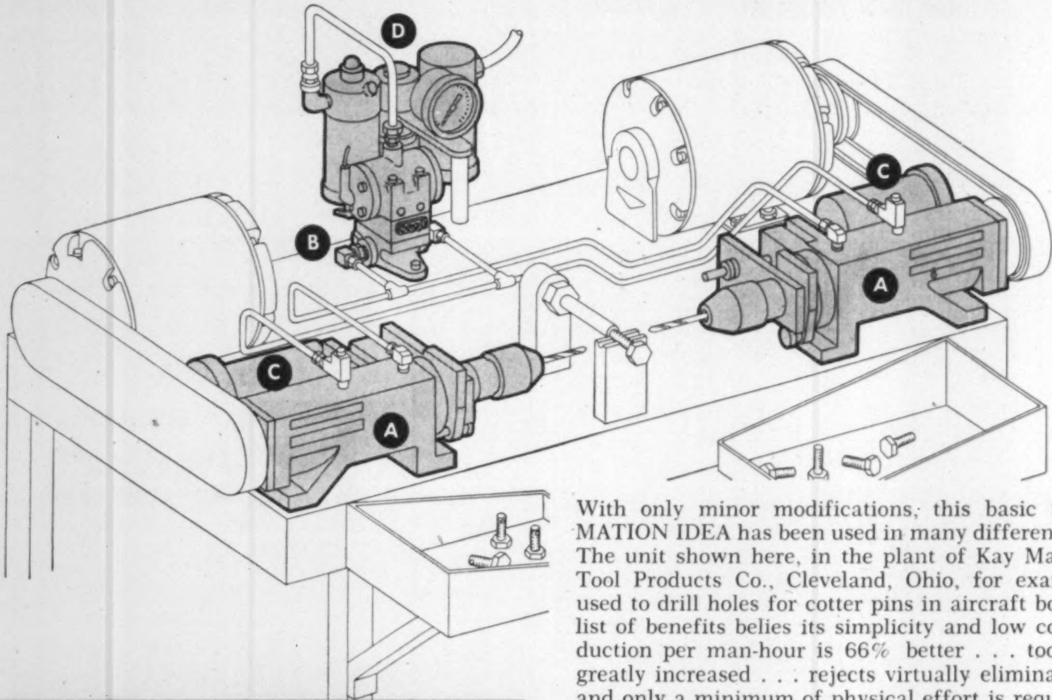
YOUR OWN MEN CAN BUILD THIS PRECISION MACHINE FOR CUTTING COSTS IN DRILLING METALS, PLASTICS AND WOOD



With only minor modifications, this basic SPOT-A-MATION IDEA has been used in many different plants. The unit shown here, in the plant of Kay Machine & Tool Products Co., Cleveland, Ohio, for example, is used to drill holes for cotter pins in aircraft bolts. The list of benefits belies its simplicity and low cost: production per man-hour is 66% better . . . tool life is greatly increased . . . rejects virtually eliminated . . . and only a minimum of physical effort is required for what formerly was a very fatiguing operation.

The machine is built around two compact interlocked Bellows-Locke Model 22A Drill Units — air operated, hydraulically controlled — mounted horizontally in opposed positions. Automatic feeding, positioning and ejection could be incorporated easily by the addition of other Bellows "Controlled-Air-Power" Devices. This SPOT-A-MATION IDEA can be readily adapted to perform a wide range of other operations, such as punching, forming, riveting, crimping, etc., by using such other Bellows work units as The Bellows Air Motor® in place of the Drill units.

This machine is typical of the ways cost-conscious men the world over are using Bellows "Controlled-Air-Power" Devices to secure faster, better, lower-cost production. Opportunities exist in your plant, too. Why not investigate — *today!*

As shown in the photo above and "keyed" in the drawing, this shop-built drilling machine consists essentially of two low-cost, air-operated Bellows-Locke Model 22A Drill Units (A), a Bellows Electroaire® operating control valve (B), two Bellows Hydro-Checks® which provide smooth precision operation (C) and a Bellows Lubri-Air® Control Unit which cleans, regulates and lubricates the air supply (D). Not visible is the foot-operated control pedal.

697C-3

THIS "SPOT-A-MATION IDEA" FILE IS YOURS ON REQUEST

Contains installation data, wiring diagrams and equipment lists for the "Spot-A-Mation" idea sketched above, as well as for scores of similar ideas you can use. Write Dept. AU-161, Bellows-Valvair, Akron 9, Ohio.

Bellows-Valvair
AKRON 9, OHIO
DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

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JANUARY 1961
Vol. 8 — No. 1

The Magazine of Automatic Manufacturing Operations

AUTOMATION

A PENTON PUBLICATION

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Penton Building, Cleveland 13, Ohio

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automation outlook

STEREOTYPES

FROM THE PENS of the crystal gazers still flow statements dealing with the effects and the future when automation in industry has reached fulfillment. In one way of thinking, perhaps these can best be classified as stereotypes. They are repeated so often and in so many shades, they become accepted as truths even though their basis in fact is questionable or lacking.

Typical of the stereotypes that provide the background for altogether too many dire conclusions regarding the future is this one: "This completely automatic factory has some 42 machines which are fed in the morning and at noon, and the components removed twice a day. Nobody goes into that factory at all except the feeders and the people who take away the products. The machines were controlled by punched cards, but by now they are probably controlled by magnetic tape."

Although we find such comment rather intriguing to ponder, it is disconcerting to say the least. Amid all the conjecture and highly imaginative writing, little is said regarding the hard-core facts of life. This type of speaking ignores the need for detailed data on just how to arrive at this level of operation, how to begin to automate operations with realistic economic procedures—the prime problem facing today's manufacturing executives and engineers.

The stereotype impact implies that automation is a cut-and-dried accomplished fact. But before some of the "amazing" plants pictured come to pass, a great deal of basic engineering development and research is still needed. There is vital need for down-to-earth data dealing with technical automation fundamentals as well as with the planning and organization steps necessary to develop the manufacturing operation into an automated system.

Today, it is important that management discard any stereotype views and really know the facts that directly concern their business. Commenting on our capacity to meet competition General Electric's Chairman, Ralph J. Cordiner had this to say at the recent National Foreign Trade Council meeting, "Foreign competition in the United States market can be met or at least kept within manageable proportions, particularly in the capital-intensive industries whose products do not have a high labor content and in industries which, with full automation, will approach such characteristics.

"It will require ingenious management, diligent and co-operative employees, ceaseless innovation, greatly accelerated investment in automation, greater responsibility on the part of union officials who seem determined to price their union members out of the domestic as well as the world market, continued control over inflation, and some constructive changes in government policy. This country's best defense is a vigorous technological offensive. We must develop new businesses, new products, and new processes that cannot be easily matched. Primarily these are the businesses that require a high capital investment, a highly educated labor force, and a highly advanced technology."

We have a job cut out for us. Don't be fooled with the stereotypes.

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BPA NBP

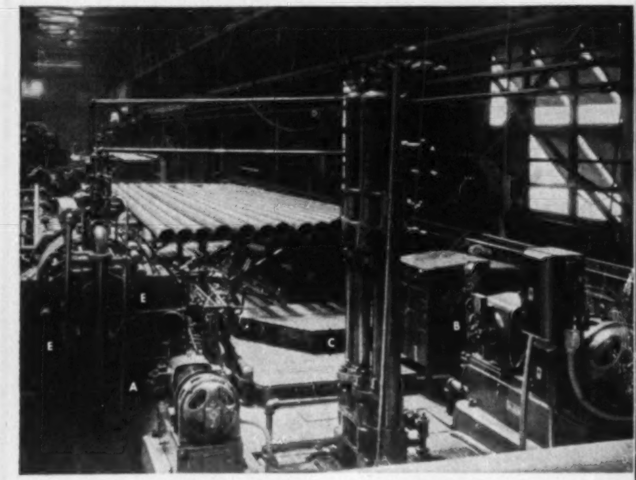
...Fluid Power news

REPORT
NO. 11,803
TEST MORE
PIPE—LONGER
WITH
OILGEAR

From Oilgear *Application-Engineering* Files

HOW OILGEAR SYSTEM POWERS PIPE TESTER EFFICIENTLY AFTER 23 TROUBLE-FREE YEARS

DATA: To supply power and control system for five functions of a hydrostatic pipe testing machine designed for a wide variety of pipe sizes and testing pressures ranging up to 6000 psi. Linear drives and controls were needed to: *1.* Actuate jaw-type clamps to hold and prevent pipe from buckling. *2.* Traverse testing head rapidly to and from testing position. *3.* Hold testing head against pipe under testing pressures. *4.* Actuate "knockout" arms to eject tested pipe from machine. *5.* Actuate an intensifier to boost water used for testing from city pressure to any selected testing pressure up to 6000 psi. *Specific Operating Requirements:* Simple, safe, dependable; capable of continuous, 'round-the-clock operation, 6 days per week in highly humid atmosphere; cycle rapidly for economical production; require a minimum of maintenance to prevent costly, line-stopping downtime; must be compact to conserve valuable floor space, economical in the use of electrical power.



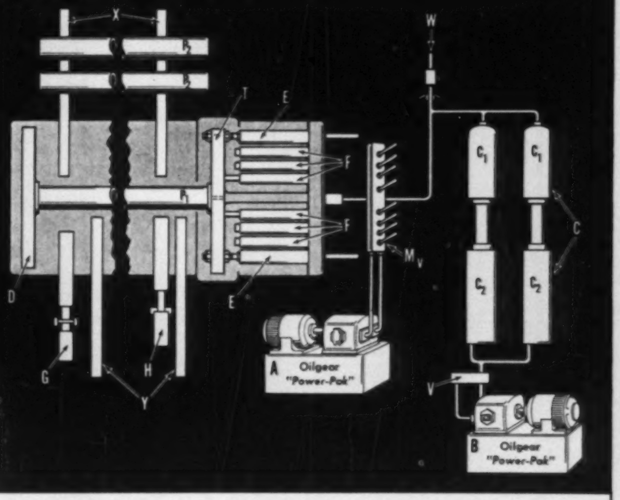
Hydrostatic Pipe Tester with *Oilgear Application-Engineered Fluid Power System* as installed in 1937, and operating continuously since that time. Oilgear "Power-Paks" (A,B), Intensifier (C), Rapid Traverse Testing Head Cylinders (E) are indicated by arrows. Manifold and Control Valves at operator's station (M_V in drawing) are clearly visible, as are the direct-reading, operating pressure gages on the "Power-Paks." Testing pressures are quickly preset with a small handwheel on "Power-Pak" (B)—not visible. Pipe to be tested rolls directly from pre-testing storage racks, at right, directly into the machine.

SOLUTION: An *Oilgear Application-Engineered System* consisting of two Oilgear Heavy-Duty "*Power-Paks,*" Directional Control Valves, and "Custom-Quality" Cylinders. Each "*Power-Pak*" uses an Oilgear Heavy-Duty One-Way Variable Displacement Radial Rolling Piston Pump with automatic pressure unloading control to reduce pump stroke when holding a preset pressure indefinitely; eliminate excessive heating and power loss; reduce electrical power input requirements. Oilgear Pumps contain integral auxiliary systems for pilot, supercharge, cooling and filtering . . . with constant pressure and flood self-lubrication, conservatively loaded anti-friction bearings, and large internal passages—mechanical and hydraulic friction is reduced to a minimum for high efficiency . . . virtually guaranteeing a long, trouble-free, maintenance-free life.

USER REPORTED IN 1938—"*. . . after one year of operation we have nothing but the highest praise for the Oilgear Equipment on this pipe tester.*"

USER REPORTS IN 1960—"*This machine has given us years of trouble-free service, operating around the clock six days a week . . . maintenance has been at a minimum, with occasional changes in intensifier packings, as would be expected in normal operation . . . performance has been completely satisfactory.*"

Application-Engineered Fluid Power System For Hydrostatic Pipe Testing Machine

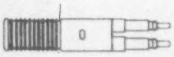


HOW IT WORKS: Pipe to be tested (P_2) rolls from storage rack (X) into cradle of machine between Testing Head (T) and Tail Carriage (D). Testing Head (T) is moved forward quickly by Double-Acting Cylinders (E). Clamping Jaws actuated by Cylinder (G) grip the pipe along its length to prevent buckling. Pipe (P_1) is pre-filled with water at city pressure (W). Single-Acting Test Head Holding Cylinders (F) move up in matching pairs—2, 4, 6, 8, 10, or all 12 can be selected—depending on pipe size and testing pressure to hold Testing Head (T) against Pipe (P_1) and Tail Carriage (D). Movement of cylinders (E, F, G, H) are all controlled by valves mounted on Manifold (M_V) which direct fluid flow from Oilgear "*Power-Pak*" (A). Water at preselected test pressure from Intensifier (C) then exerts pressure on Pipe (P_1). Oilgear "*Power-Pak*" (B) supplies *Fluid Power* through Valve (V) to actuate Hydraulic Intensifier Cylinders (C_2) increasing pressure in Water Cylinders (C_1) to any desired pressure up to 6000 psi. After pipe is inspected, intensifier pressure is released, Testing Head (T) is rapidly retracted, and Knockout Cylinder (H) actuates mechanism to eject tested pipe onto rack (Y). Machine is then ready to start a new test cycle.

With Oilgear Heavy-Duty System Components designed for thousands of hours of continuous service at full rated load, savings are compounded with every hour of uninterrupted performance. That's why machinery and equipment manufacturers and *their* customers say . . .
"*For the lowest cost per year . . . it's Oilgear!*"

For solutions *to YOUR linear or rotary Controlled Motion problems, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .*

THE OILGEAR COMPANY
Application-Engineered Controlled Motion Systems
1598 WEST PIERCE STREET • MILWAUKEE 4, WISCONSIN
Phone: Mitchell 5-6715 . . . Direct Distance Dialing Code 414

Simply plug in  *any automatic cycle . . .*

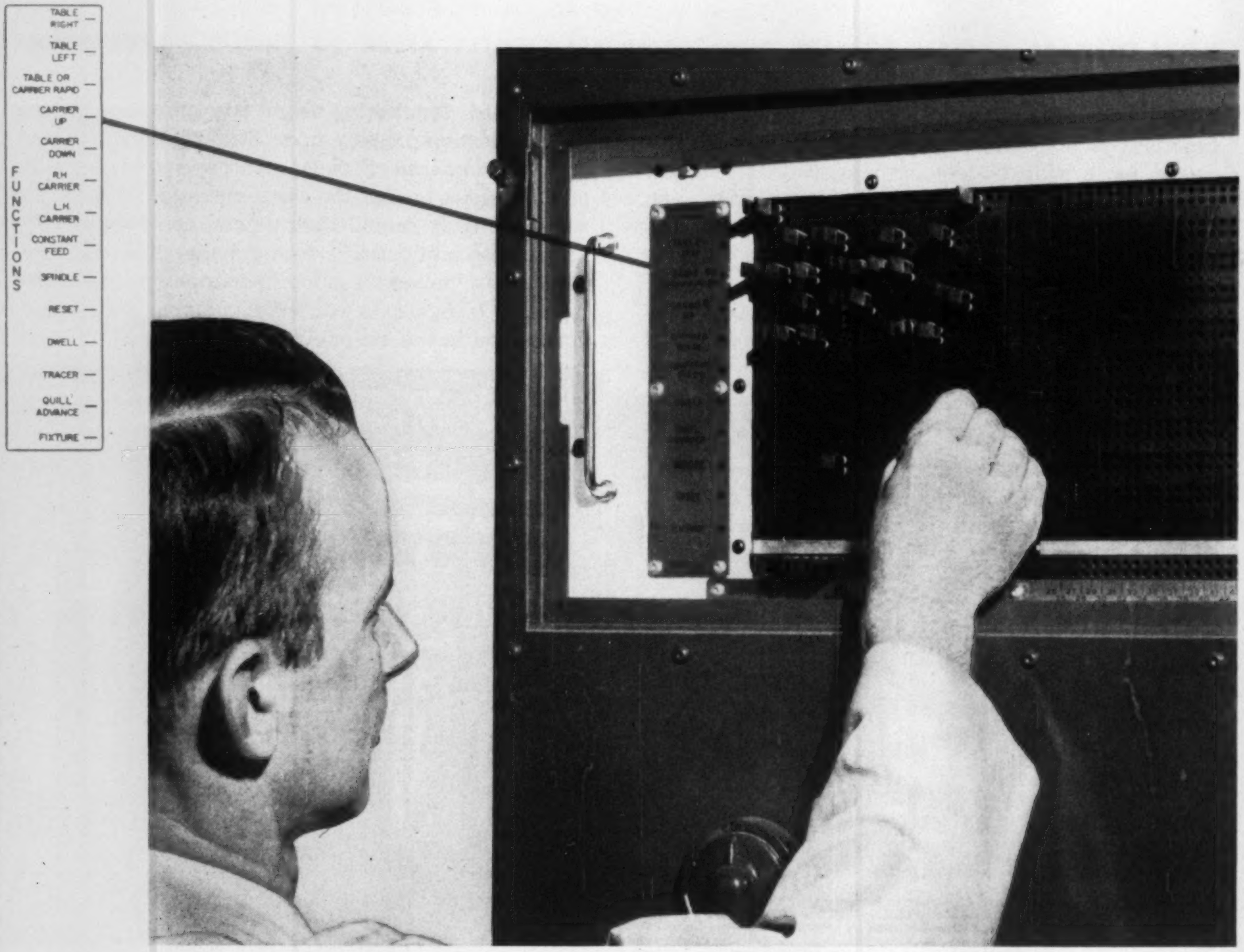
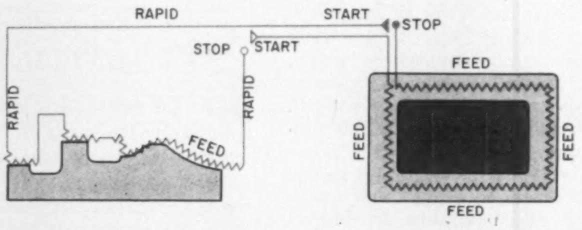


TABLE RIGHT
TABLE LEFT
TABLE OR CARRIER RAPID
CARRIER UP
CARRIER DOWN
R.H. CARRIER
L.H. CARRIER
CONSTANT FEED
SPINDLE
RESET
DWELL
TRACER
QUILL ADVANCE
FIXTURE
FUNCTIONS

A row of 24 holes opposite each machine function allows operator to plug in complex automatic milling cycles involving up to 24 events. Additional panels may be added, as in the two-unit illustrated.


RAPID
START
STOP
STOP
START
FEED
RAPID
RAPID
FEED
FEED
FEED
FEED
FEED

Cycle diagram superimposed on two parts machined in one automatic cycle on a 200 Series Tracer Controlled HyPowermatic Milling Machine.

BUILDERS OF FINE MACHINE TOOLS: KNEE TYPE AND BED TYPE MILLING MACHINES • DIE SINKING MACHINES •

THE CINCINNATI MILLING MACHINE CO., CINCINNATI 9, OHIO

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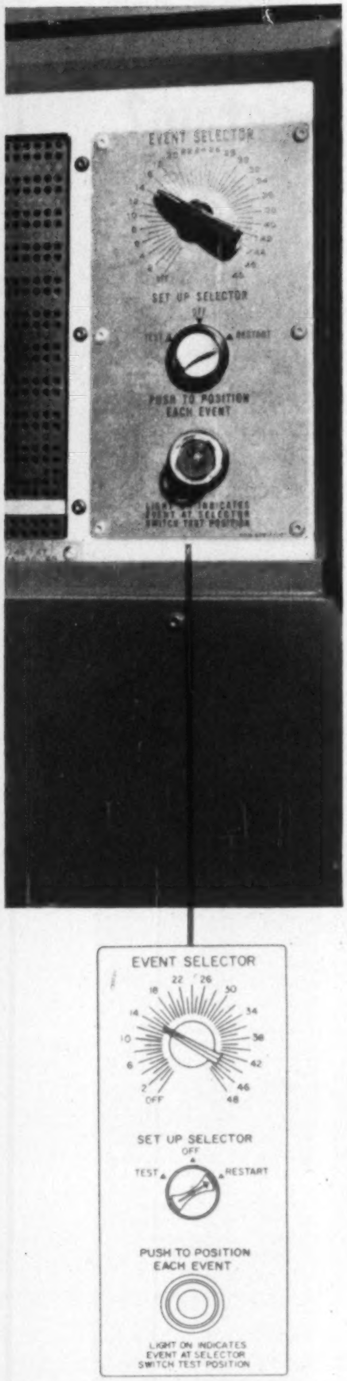

Cost advantages of automatic cycle milling now are available for smaller lots than ever before. New CINCINNATI Telematic Control is the answer. This new type of control is simple to use and versatile beyond imagination.

The operator programs all automatic functions of the cycle by merely inserting plugs in a panel board. If desired, a mask can be made for repeat jobs, exposing only the necessary holes. In addition to controlling all functions or movements of the machine table and spindle carrier, Telematic provides for auxiliary operations such as fixture clamping or indexing.

Telematic Control is standard equipment on CINCINNATI 100 and 200 Series Automatic Rise-and-Fall and Tracer Controlled HyPowermatics. These new milling machines incorporate many other exclusive feature-advantages. Hydramech table drive, for example, automatically eliminates backlash and assures smooth cutting for up-milling and down-milling, feeding right and left. Bed ways are square gibbed, flame hardened and automatically lubricated. A variable speed hydraulic motor positions and feeds the spindle carrier, both up and down. Table feed may be automatically varied during the cut.

No other milling machines are comparable to CINCINNATI 100 and 200 Series HyPowermatics. And with Telematic, the newest, most versatile and simplest of the operator controlled programming methods, the HyPowermatics are years ahead in low-cost productivity. Get complete details . . . write today for Catalog M-2020-2.

CINCINNATI 200 Series Plain Tracer Controlled HyPowermatic Milling Machine with Telematic Control, performing the automatic milling operations diagramed on the left page. Catalog No. M-2020-2 covers all styles.

CINCINNATI

CINCINNATI®

MILLING MACHINE DIVISION

CUTTER AND TOOL GRINDERS • ELECTRICAL DISCHARGE MACHINES

Circle 656 on Page 35

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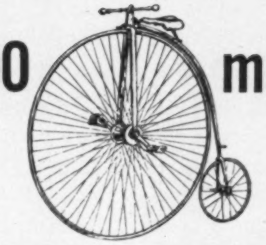
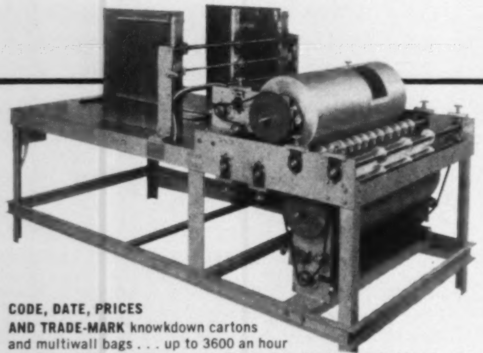
1961 PACKAGING LINE

with an 1890 marking set-up?

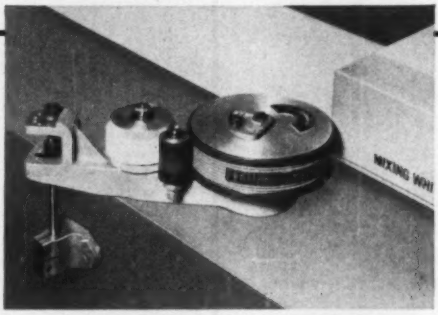


Don't shackle your packaging line with an obsolete marking system. Look into the four IME imprinters on this page. All four synchronize to the speed of the line. All work smoothly, print distinctly, save you and customers time and bother. All offer heavy-duty construction for first-rate performance.

1961 packaging demands 1961 marking: IME marking. Performance guaranteed. For detailed, illustrated brochure write today. Dept. A

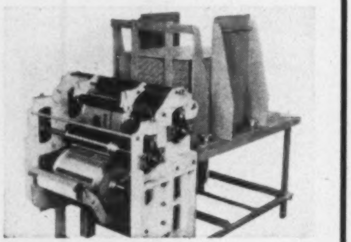


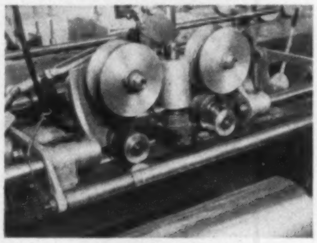
CODE, DATE, PRICES AND TRADE-MARK knowkdown cartons and multiwall bags . . . up to 3600 an hour . . . with the new Flexopress. Prints top, bottom and sides in one pass. Attaches to present units. Ideal for web and sheet-fed work, handling webs 1½" to 100" wide. Open-fountain inking system. Removable plate cylinders for off-press registration. Available in self-contained or "attachment" models.



PRINTS boxes, cartons and containers at production-line speed, whatever that speed may be. The Whippet® conveyor-line marker will mark all that passes it . . . easily adapted for top or side marking, too. Interchangeable type. Easy to maintain.

MARKS UP TO 3000 PER HOUR CARTONS AND BAGS AUTOMATICALLY: the #7 Autoprinter® Prints well on nearly every flat, absorbent surface, does one or both sides in one pass. Ink dries fast, doesn't cake . . . no need to clean rollers after use.





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Circle 657 on Page 35

AUTOMATION news

Today's events and developments in the field of automation

Controlled Crystal Growing Now A Commercial Reality

Instruments on central control panel show the conditions inside each of the 20 growing vessels used in the plant. Individual controllers maintain preset temperatures in the two zones of each vessel.

PRODUCTION of man-made quartz crystals by an automatically controlled process has been started on a commercial basis. Western Electric Co., unveiling the new facility at their Merrimack Valley Works, pointed out that it is the world's first factory built to mass produce quartz crystals for communcations purposes.

Although quartz in a variety of forms is the world's most common mineral, most of the large high-quality crystals required for manufacture of communications equipment from natural sources must be obtained from the interior of Brazil. Cost of such natural quartz in the final plate form used for electronics purposes is about $1500 per pound. The new process applies controlled heat and pressure to grow large synthetic crystals using low grade quartz chips as raw material. Quartz to be used as raw material or nutrient in the process, is widely obtainable. Savings of $500,000 annually are expected through use of the new hydrothermal process developed by Bell Telephone Laboratories.

Synthetic quartz crystals are being removed after 21 days in a growing vessel. The vessels are sunk in pits because of easier access. Cylinders in background are used as safety shields above vessels.

Heart of the process is the application of pressure near 25,000 psi at temperatures up to about 750F. The process is carried out in vertical cylindrical chambers inside high-strength chromium-molybdenum vessels. The nutrient material is lowered in a basket to the bottom of the chamber, and thin seed plates cut from quartz crystals are lowered on a rack into the top of the chamber. Water and sodium hydroxide are added before the closure is locked into place.

The vessel and its contents are heated by electric strip heaters wrapped around the outside of the vessel. The heating of the contents within the closed chamber causes the increase of pressure, and the volumes of the materials put into the chamber are carefully measured so that desired pressures will be obtained at operating temperatures. The bottom of the vessel is heated to about 750F and the nutrient dissolves into the alkali solution.

The top of the chamber is maintained at a lower temperature, so that crystals of quartz deposit from the solution and slowly build up on the seed plates. About 21 days are required to grow crystals of the size used at Merrimack Valley.

To maintain desired temperatures, the strip heaters are spaced along the entire height of the vessel, and less insulation is used around the seed plate zone to promote heat loss. Each zone's heaters are tied to a common power supply. The power supplied to each zone is controlled by a system developed by Western Electric engineers working with Taylor Instrument Co.

Thermocouples are located in wells at the bottom of the vessel and in the closure. An electrical pressure transducer is also provided. Two recorder-controllers are supplied on the central control panel for each of the 20 growing vessels in the plant. These individual controllers maintain the preset temperatures in the two zones of their respective growing vessel.

Two sets of special instruments are provided to control individual vessels during the critical hours at the start of a run. Control provisions are such that control of a vessel is shifted automatically from the start-up instruments to the individual instruments after the start-up period. Other functions of the control system are also automatic so that the growing process can continue nights and weekends when operators are absent.

Fifth Automation Conference Coming Up

ORGANIZATION of the Fifth Conference on Manufacturing Automation is well under way. Co-sponsored by the Schools of Mechanical Engineering and Industrial Engineering of Purdue University, the Manufacturing Engineering Council, and the editors of AUTOMATION, the manufacturing conference will be held April 17, 18, 19, 1961, on the Purdue campus at Lafayette, Ind.

Once again an integrated series of technical sessions and discussion groups will provide an interchange of practical know-how on industrial automation. Authoritative speakers from diversified industries will present papers on various phases of the planning, building, and operating of automated machines, lines, and plants. More details on the conference program will be given in future issues of AUTOMATION.

Automation Boosts Market For Liquid CO_2

PRODUCTION of liquid carbon dioxide has doubled in recent years because of its increased use as an industrial coolant. New applications are being found for the fluid in many processes where dry ice normally would be used. According to **C. E. Wolfe**, vice president of Cardox Div., Chemetron Corp., automation in industry has boosted liquid carbon dioxide consumption because of the requirement for a coolant that is easily controlled and metered. Last year, 398,897 tons of liquid carbon dioxide were produced in the United States, compared with 204,170 tons in 1955. "Liquid carbon dioxide leads to better production methods," Wolfe said. "There are no storage losses through sublimation, labor costs are reduced, and better and faster production methods can be adopted."

CBS Electronics Offers Mechanical Services

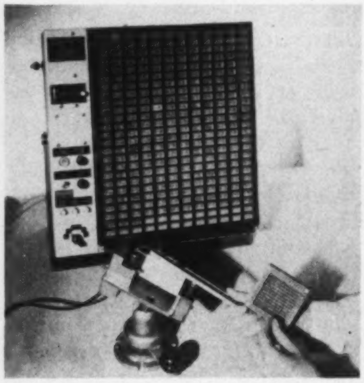
INDUSTRIAL and military organizations can now take advantage of the products and services of the Mechanical Equipment Dept. of CBS Electronics, manufacturing division of Columbia Broadcasting System Inc. It will design, develop, and construct special mechanical and electromechanical equipment

Counts Winding Points on Memory Plane

DEVELOPMENT of an automatic programmer, which keeps track of the winding points on magnetic core memory planes, has stepped up production rates and reduced the possibility of error. One of the problems involved in assembling satisfactory core matrices has been that the operator must keep in mind at all times the tiny points through which she passes the wire and must remember the exact number of windings she has completed.

The programmer, designed by International Business Machines Corp., resembles a pinball machine. When the machine is turned on, boxes on the grill light-up, giving step-by-step information and instructions at each stage of the winding sequence.

Operation of the programmer is governed by a fixed program which is determined by switch controls on both the automatic programmer and the assembly fixture that is used with it. The prepared program provides three types of information necessary to wind a core matrix—preliminary instructions, winding and terminating locations, and checking information. The core matrix is secured to the assembly fixture by a power arm which pivots so that first one side of the matrix is visible and then the other. As the operator passes the wire through a core, she flips the power arm and the next instruction, which lights up on the register, gives the next winding location. The *Number of Turns* boxes at the top of the grillwork light up to keep the operator informed of the turning count. This total count should correspond with that appearing on the counter on the programmer panel, giving the operator a continuous check on the accuracy of her operation. If an error is detected, the counter can be manually reset after the error is corrected.



University surveys indicate:

STARTING SALARIES OF ENGINEERS ARE DECEPTIVELY HIGH

By James M. Jenks

TWO SEPARATE STUDIES of the salaries made by college graduates appear to contradict the commonly held belief that engineers today make out better financially than their classmates who major in non-technical subjects.

Both surveys were conducted by large universities. The first polled graduate engineers; the second, company executives. And both resulted in identical findings! That is, the average engineer today – despite a deceptively high starting salary—climbs fast but not far.

The need for technically trained men in recent years has exceeded the supply to such an extent that companies have been forced to bid for their services—to actually set-up "recruiting" offices on college campuses all over the country. Thus, starting salaries have gone up and up. But the income ceiling for these technically-trained men is lower than that for managerial personnel.

Despite the substantial head start engineers have, the differential in money earned over a ten-year period averages out at $7,000 more for the management man. And from the tenth year on, the administrator's salary obviously outstrips that of the engineer by a wider and wider margin.

This, of course, is not to say that engineering students would be wise to shift to the study of business administration—or that working engineers face a bleak future. Quite to the contrary, the continuing growth of technology means that men with technical backgrounds are as ideally qualified for the highest rewards industry has to offer—*if they also have a knowledge of the underlying principles of business.*

FREE..."FORGING AHEAD IN BUSINESS"

If you want to avoid the thorny barriers to success—if you're ambitious, determined to move up fast—send today for the Institute's 48-page descriptive booklet, "Forging Ahead in Business".

It explains what a man must know today to make $15,000 or more a year . . . what he must do to accumulate this knowledge. It tells why men of equal ability fare so differently in the race for better jobs and bigger salaries. It analyzes the causes of failure . . . the reasons for success. And it outlines an executive-training program which is so complete and so scientific that each day subscribers are brought a little closer to a mastery of business procedures.

There's no charge for "Forging Ahead in Business." And no obligation . . . other than the obligation to read it thoughtfully, and decide for yourself whether the training it describes is meant for you. To obtain your complimentary copy, simply fill out and return the coupon. It will be mailed to you promptly.

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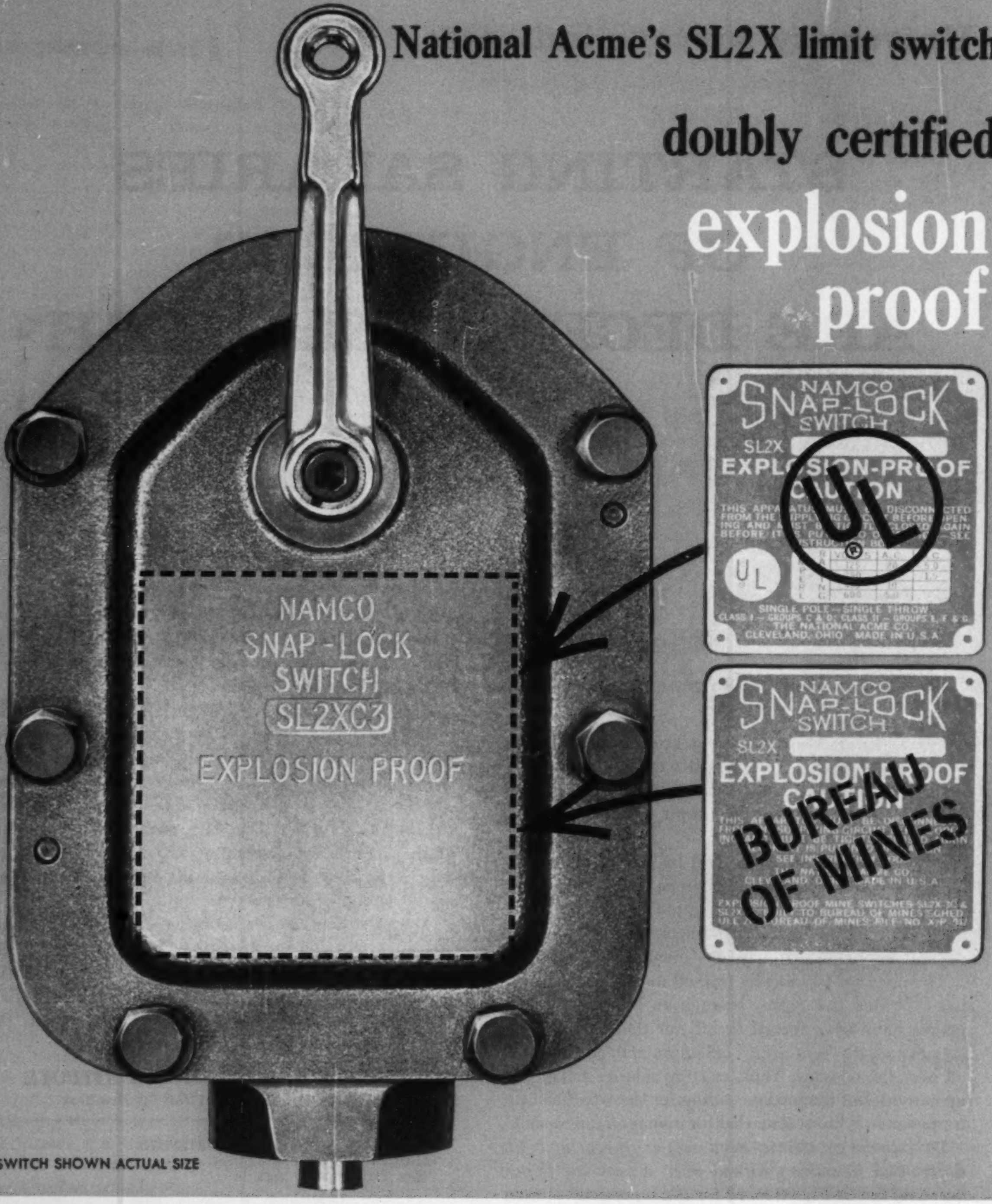
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Specify National Acme's SL2X . . . and eliminate limit switching problems under explosive conditions. Tested and certified "explosion-proof" by both Underwriters' Laboratories and the Bureau of Mines, the SL2X is specifically designed for use in the mining, chemical, process industries . . . anywhere explosions cannot be tolerated. Latest of National Acme's dependable SL2 "Machine Life" Limit Switches, the SL2X also offers . . . a variety of cam arrangements for extreme operating flexibility . . . ample overtravel (67°) and by-pass (90°) . . . light operating pressure (12½ lbs. at 1½" radius). Get all the details on this new standard of limit switching dependability and safety. Call, write or wire.

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Circle 659 on Page 35

and systems for outside users. The department will draw on experience gained in designing and building equipment such as that in operation at CBS Electronics' modern receiving tube plant at Danvers, Mass.

Typical products include: Complete automatic production lines; high-speed automatic processing equipment; and semiautomatic equipment for fast, accurate assembly of small, delicate components. The group will also give design and development assistance or discuss equipment designs which the customer wants manufactured.

AUTOMATIC control systems, manufactured by Hagan Chemicals & Controls Inc., will be used on an adjustable-blade, axial compressor for blast furnace duty to be installed by United States Steel Corp. at its Edgar Thomson Works in Braddock, Pa. The controls will govern weight flow from the compressor by automatically controlling adjustable stator blades, and will also protect the compressor against surge.

Trade-In Plan For Screw Machines

TRADE-IN allowance of $500.00 on old screw machines is being offered by Brown & Sharpe Mfg. Co. The allowance will apply in the United States toward the purchase of new automatic screw machines. The new plan offers the $500.00 allowance for each old B&S automatic screw machine regardless of age or condition and on the basis of one old for one new machine. Old machines taken in trade will be returned to Providence and scrapped.

The offer is part of a program designed to upgrade and modernize screw machine departments and plants. Results of surveys showed that almost 50 per cent of the single spindle automatic screw machines now in use are from ten to twenty years old. In some instances, machines fifty years old are still being used.

ROGER W. BOLZ
Publisher and Editorial Director

JAMES C. KEEBLER
Editor

AUTOMATION Leaders Assume New Responsibilities

CONTINUING EXPANSION in the field of industrial automation has been accompanied by a similar growth of service rendered by AUTOMATION magazine to those concerned with this technology. Latest step to implement further growth of AUTOMATION's service is represented by the announcement that **Roger W. Bolz** has been named Publisher and Editorial Director and **James C. Keebler** has been appointed Editor.

Bolz and Keebler have been the leadership team that has had primary responsibility for the shaping of AUTOMATION's editorial philosophy since the magazine's inception. Roger Bolz was the first editor, and Jim Keebler the first associate editor. In 1957 Jim became managing editor, and in 1960 Roger was named publisher-editor.

With the new assignments, both men will assume broader responsibilities in furthering AUTOMATION's effectiveness in serving the field of automatic manufacturing operations. Publisher and Editorial Director Bolz will devote more effort to the over-all publishing activity but will continue to comment editorially on the automation scene in the Outlook department of the magazine. Editor Keebler will handle an increasing area of editorial interests.

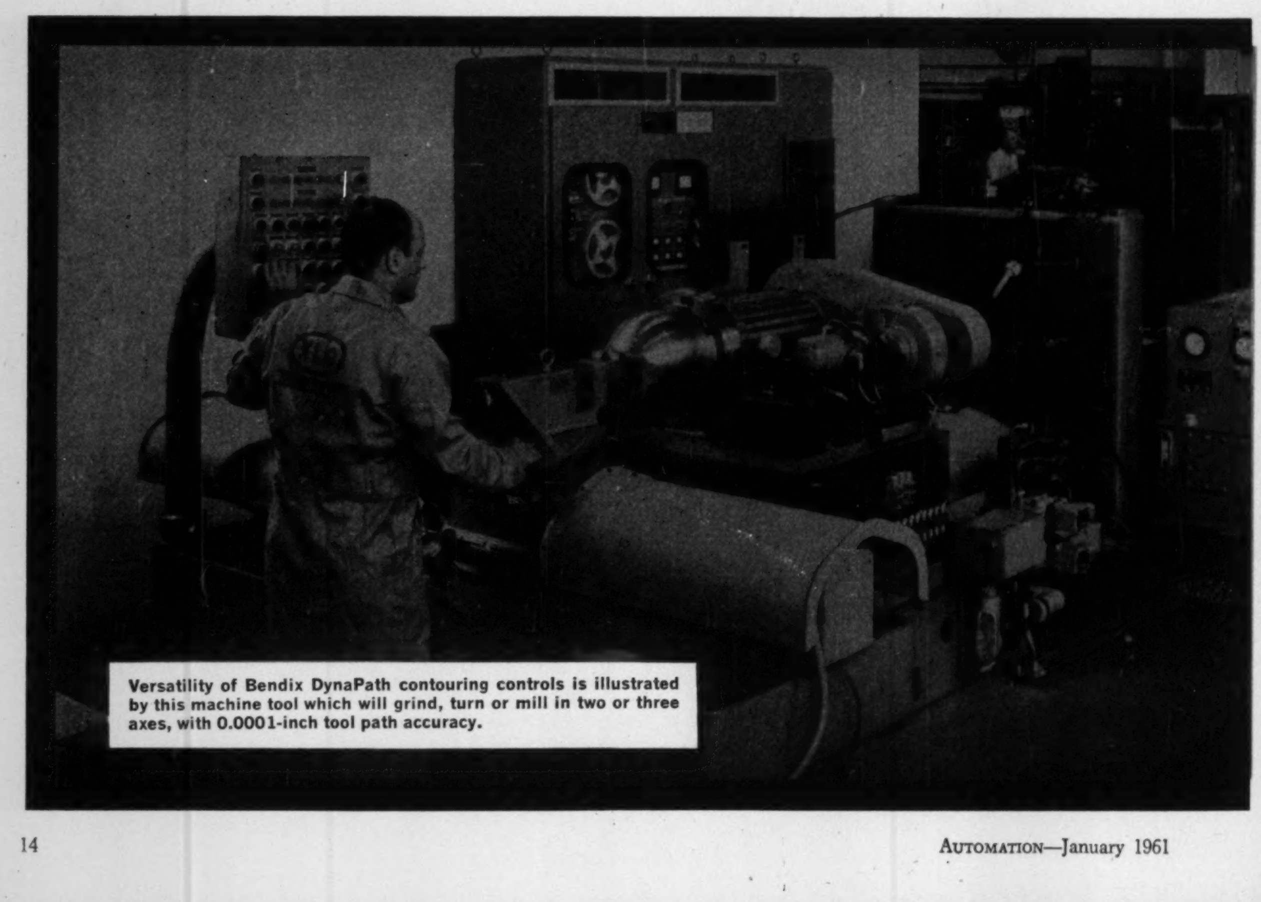
Roger Bolz is widely known as an engineer, writer, and editor. As an authority on manufacturing automation, he is the only editor requested to testify before the Subcommittee on Automation and Energy Resources of Congress. His statement keynotes the latest testimony "New Views on Automation" just published. He has spoken on various aspects of the subject before hundreds of groups throughout the country, and on television and radio. A registered professional engineer (Ohio) with an engineering education from Case Institute of Technology, Roger has been acclaimed for his authorship of the two-volume work *Production Processes—Their Influence on Design.* He is also a contributor to the ASME Handbook, Plant Engineering Handbook, Automation in Business and Industry, Compton's Encyclopedia, and Kent's Mechanical Engineering Handbook, besides being the author of numerous articles.

Prior to AUTOMATION's inauguration, Roger Bolz was on the staff of Penton's *Machine Design.* He entered the editorial field after practical production and design experience in aircraft, shipbuilding, electric motors, general products, machinery, machine tools, and processing equipment. Other experience included materials handling, processing plant layout, and service as a works engineer in charge of automatic machine design and development and plant maintenance for a large chemical-metallurgical firm.

Roger is a member of the American Society of Mechanical Engineers, Institute of Radio Engineers, American Management Association, Instrument Society of America, Manufacturing Engineering Council, Sigma Delta Chi, American Ordnance Association, and National Society of Professional Engineers. He

BENDIX PROVIDES SYSTEMS EXPERIENCE TO MAKE NUMERICAL CONTROL WORK FOR YOU

Numerical control is a proved concept in metalworking. It has demonstrated its worth in scores of applications, but perhaps your manufacturing problems are different. Why not enlist the services of Bendix—long-time supplier of practical, reliable numerical control systems to most major machine tool builders. Let us be your prime source of information and assistance when the demand for increased productivity indicates a need for more modern equipment that will reduce scrap, reduce lead time, reduce inventory costs, and reduce tooling costs. Whether it's contouring, positioning or measuring, Bendix has the solution to your particular problem.



Versatility of Bendix DynaPath contouring controls is illustrated by this machine tool which will grind, turn or mill in two or three axes, with 0.0001-inch tool path accuracy.

YOU NEED BENDIX SYSTEMS EXPERIENCE when you consider numerical control for your application! Bendix offers:

1 **JUSTIFICATION STUDIES**—what can numerical control do for you?

2 **SYSTEM ENGINEERING**—applying the right control to the right machine tool.

3 **TRAINING AND SERVICE**—for maximum machine utilization rates.

The unique Bendix Systems Experience is backed up by a staff of experienced electronic, mechanical and hydraulic engineers, mathematicians, instructors, technicians, and parts planners. Our contract machining and tape-making facilities offer years of accumulated case histories on all manner of applications *and* a chance to check out *your* problems in actual practice. Why not write today for more information on Bendix Systems Experience.

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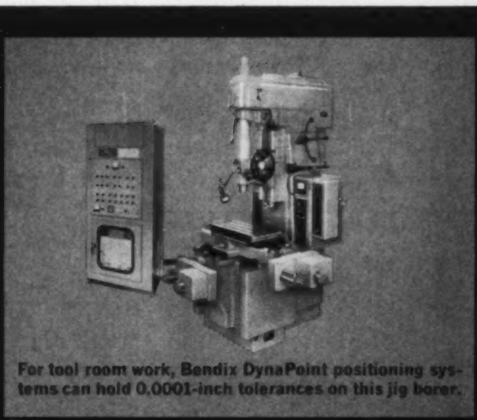
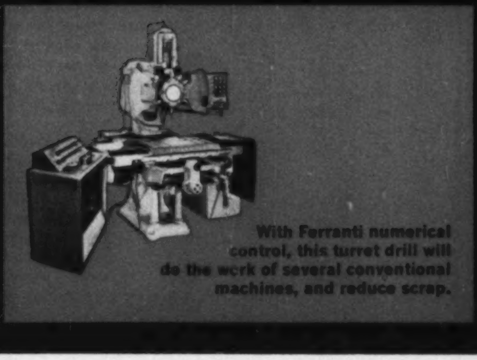

For tool room work, Bendix DynaPoint positioning systems can hold 0.0001-inch tolerances on this jig borer.


With Ferranti numerical control, this turret drill will do the work of several conventional machines, and reduce scrap.

is serving on the Cleveland Ordnance Panel of Machine Tool Consultants and the Board of Governors of the Cleveland Engineering Society.

Jim Keebler combines practical engineering background with a flair for writing and speaking. Prior to joining the staff of AUTOMATION, he spent approximately 8 years in production engineering work with a large automotive-aircraft-appliance-electronics manufacturer. His experience included assignments as tool designer, tool design supervisor, process planning supervisor, and manufacturing engineer.

Formal education acquired by Jim includes a Master of Science degree in Mechanical Engineering from Case Institute of Technology; training in U. S. Navy schools at Columbia University, Harvard University, and Bayonne, N. J.; and a Bachelor of Science degree in Mechanical Engineering from Purdue University.

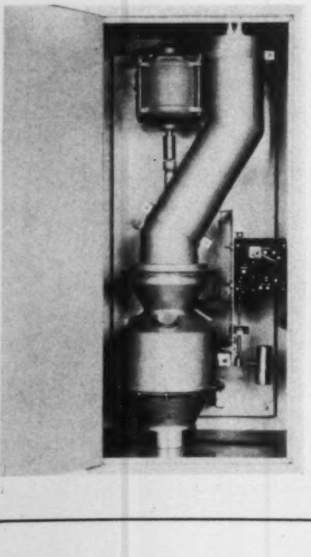
Jim Keebler is national secretary of the Manufacturing Engineering Council and a member of the American Society of Mechanical Engineers, American Society of Tool Engineers, Society of Automotive Engineers, Sigma Delta Chi, Tau Beta Pi, and Pi Tau Sigma. Jim's broad interest in education—the basic purpose of technical business journals such as AUTOMATION—finds further expression in service on the School Board of his community. He has spoken and presented technical papers before many groups around the country.

Free Engineering Statement Proposed

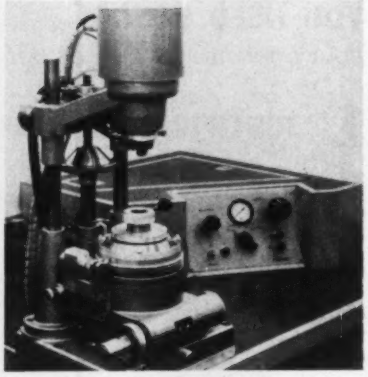
JOINT COMMITTEE of representatives from the Producers' Council and the Consulting Engineers Council unanimously adopted the following statements relating to engineering responsibilities of engineers and manufacturers.

1. Producers should establish design guidance and application specifications for their products or systems, as normal procedure without charge.
2. Designers, including architects and consulting engineers, should undertake design responsibilities for professional fees.
3. When designers or owners ask producers to provide design services beyond normal, the producers should be properly compensated for engineering services rendered.
4. Architects, engineers, producers, and contractors should join in publishing and publicizing the importance of employing competent design talents at proper compensation for the skills involved.

The joint committee recommended adoption of these statements by the Boards of Directors of both organizations and incorporation into the *Manual of Principles and Performance* of the Consulting Engineers Council.



DRY FLOW METER developed by Industrial Processes Inc. provides continuous, instantaneous or recallable stream-flow data without interrupting flow of material. The meter operates on an impact principle, translating unit weights of stream flows into electrical currents by an electronic transducer. Optional instruments can give direct readings in unit weight per unit time from local or remote stations, make permanent recordings of flow for future study, or give totaled readings for any time period desired. Addition of a controller and volumetric feeder can provide automatic control of dry-flowing material processes, with the dry flow meter supplying actual flow rate data for comparison with command or set point flow rates. Meter is designed for installation in existing spouting systems.



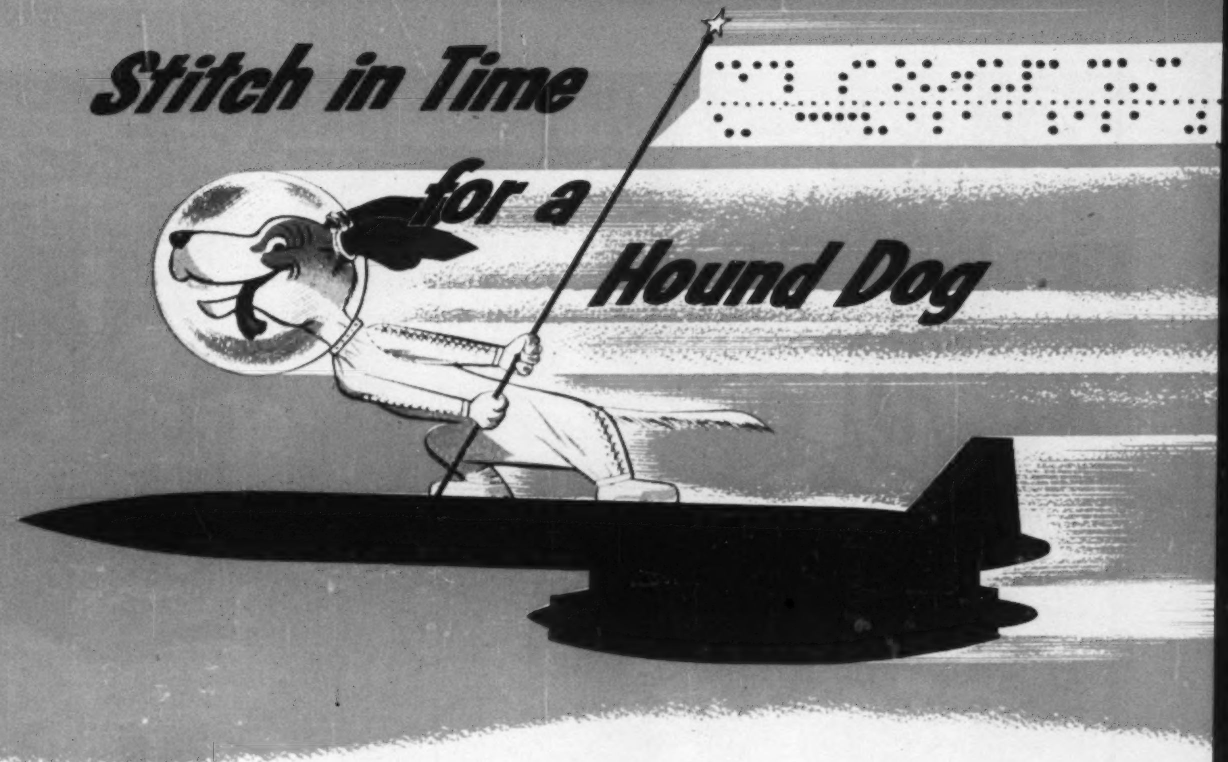
STAINLESS STEEL, monel, and other materials as thin as 0.001 inch can be spot welded on machine developed by Statham Instruments Inc. With proper power supply, the unit is capable of up to 300 spots per minute. The pattern may be a single spot, or the unit can automatically weld a ring of spots in a 3-inch radius, overlapping them for a hermetic seal. Unit shown is used to produce a hermetic seal weld between a thin diaphragm and the frame of a pressure transducer.

Customers Get Their Statements Faster Now

MONTHLY BILLING statements are now processed automatically at rates up to 6000 per hour by the 19-store retailing organization of Roos/Atkins, San Francisco. A machine, produced by Bell & Howell Phillipsburg Co., automatically gathers a customer's purchase records and monthly statement, adds a return envelope and up to four advertising folders, inserts this material in a mailing envelope, seals the envelope, imprints postage, and stacks the envelopes for delivery to the post office. The machine selects statement and purchase records for each customer from a rack of punched cards.

Saul Z. Winter, controller of Roos/Atkins, says growth of the organization created an increased mailing and billing load that made the automated equipment necessary. "Current monthly statements mailed total 125,000," says Winter, "and projections call for twice that in two or three years."

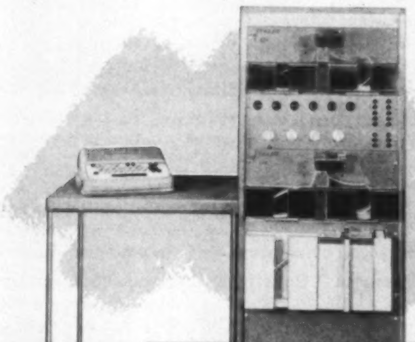
LADLE ADDITIONS FEEDERS, manufactured by Blaw-Knox Co., will be in operation next spring for the basic oxygen steel making proc-



New Tally Tape Console cuts punched tape preparation time by 600% on Hound Dog missile

Last fall, the first production model of the new Tally Tape Console was delivered to North American Aviation's Missile Division to speed the preparation of punched paper tapes. The tapes in turn program both production and preflight missile checkout systems on SAC's Hound Dog missile.

Before the Tally Tape Console was installed North American Missile Division engineers took 30 hours to make and absolutely verify a 400-foot programming tape. To make and absolutely verify a duplicate copy of the tape required an additional 75 minutes.



The Results

Now, North American Missile Division engineers using the new Tally Model 150 Tape Preparation and Editing Console make 400-foot tapes in three to four hours. Duplicate tapes are made in only 37 minutes. And Tally tapes are *guaranteed* error free.

Tally/Seattle is pleased to have played a significant role in North American's pace setting GAM-77 program which took only thirty months from design to flight of production models by SAC crews.

Tally's Tape Console simplifies and automates punched paper tape production

It features tape-to-tape duplication and verification at 60 characters per second. A keyboard visual display and shift register reduces error and operator fatigue in both punching and verifying modes. Tape corrections can be made without overpunching or splicing.

The Tally Tape Console is another new product from a creative engineering team specializing in punched paper tape technology. Your nearby Tally engineering representative can provide you with complete technical information on the Tally Tape Console or you may write directly to Dept. 06.

TALLY
REGISTER CORPORATION
1310 Mercer Street
Seattle, Washington
Phone: MAin 4-0760

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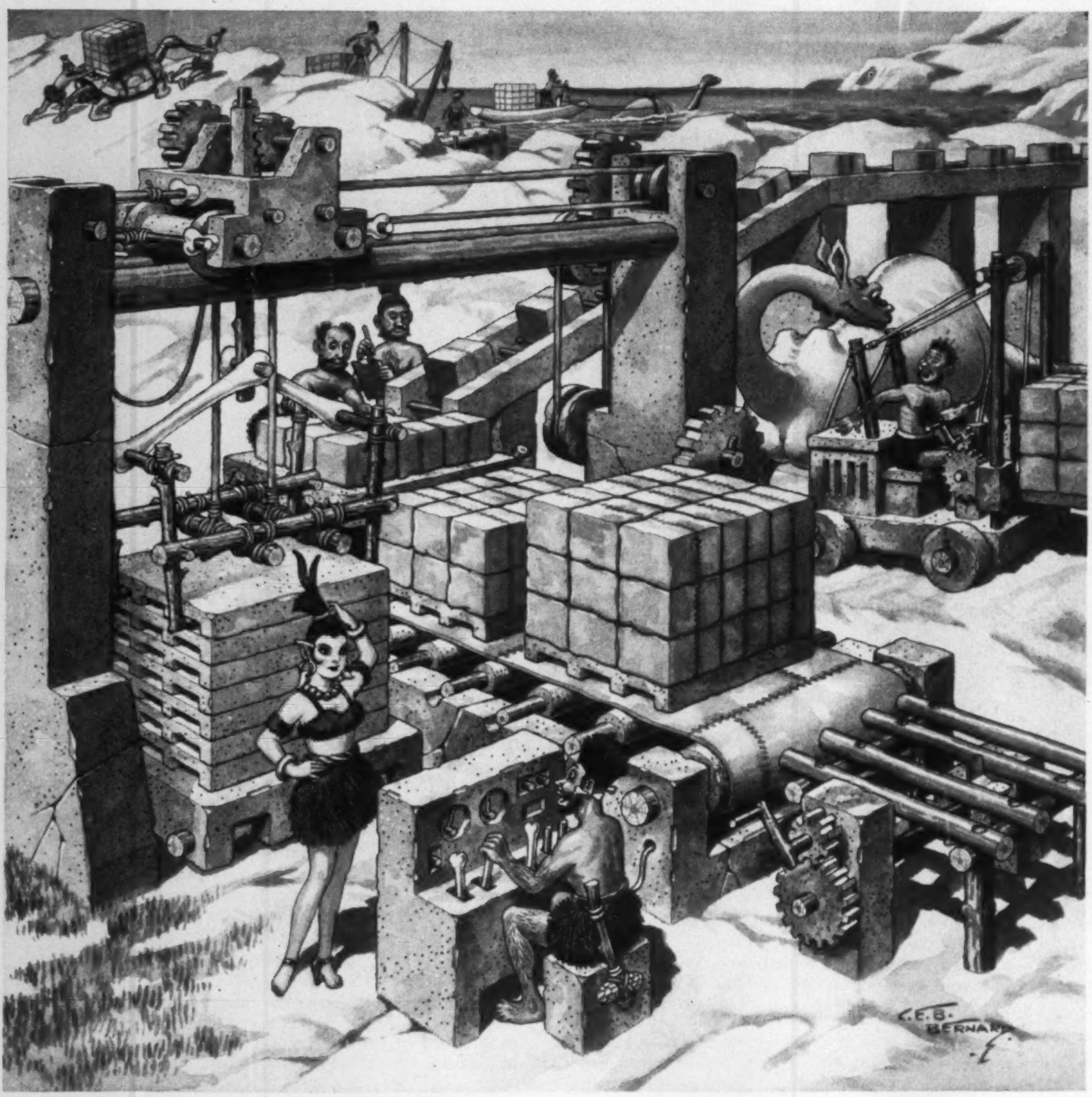
Circle 661 on Page 35



This epochal Post Paleolithic Palletizing Machine, a practically peerless example of paleontological progress, was the talk of the automation industry during the Old Stone Age. (Ca. 100,000 B.C., give or take an eon.) Part of a special pictorial history of automation by Barkley & Dexter.

GREAT MACHINES OF WESTERN MAN

This backward look at the backward days of automation is lovingly dedicated to industry everywhere by Barkley and Dexter with this reminder: that industry anywhere can progress and profit from the forward looking services of B & D, one of the nation's foremost specialists in industrial mechanization and automation.

You should know more about B & D. Here is what our service consists of:
PLANNING — we determine if mechanization can help you; where it can help you; how it can help you; how much it is likely to cost; how much it will save.
DESIGN, DEVELOPMENT, PRODUCTION — working with your personnel, or independently, we custom design, develop and build automatic equipment and controls to replace hand labor or perform new operations.
TROUBLE SHOOTING — our long experience can help you eliminate bugs from your own production lines.

For further information, send for the folder on our services. Or better still, write us about your problem.

BARKLEY & DEXTER INCORPORATED
50 FRANKFORT STREET, FITCHBURG, MASSACHUSETTS—*Pioneers in Automation*

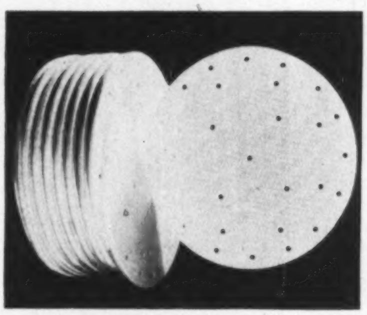
ess at the Cleveland Works of Jones & Laughlin Steel Corp. The feeders, designed to make specific quantity additions of ferro alloys to the ladle at controlled rates of feed, will be equipped with an emergency feed. These will be the first two such feeders used in the basic oxygen process.

System Checks Temperatures Against Programmed Values

DESIGN AND DEVELOPMENT project for a monitoring and alarm system that is capable of measuring signals from several thousand thermocouples, ten times each second, has been announced by the Datalab Div., Consolidated Electrodynamics Corp. The system is slated for use at the Savannah River Laboratory, which is operated by E. I. du Pont de Nemours & Co. under prime contract with the U. S. Atomic Energy Commission.

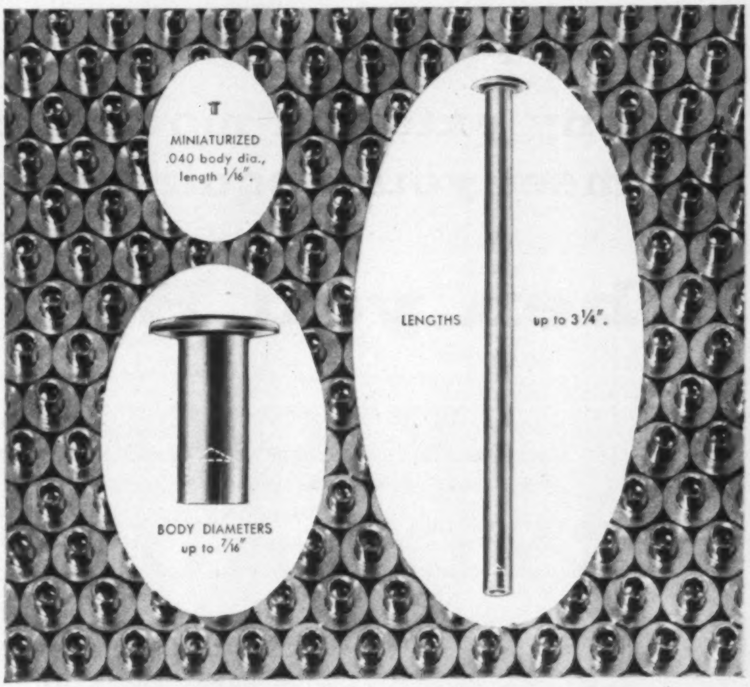
The system will indicate whenever individual temperatures, or computations based on several temperatures, exceed programmed values. A readout panel will provide an operator with information that indicates certain conditions in the monitored process and also certain states of the system itself.

Automatic checking features will



LINEAR POLYETHYLENE sieve plates required for fractionating towers used in chemical separation are being manufactured in large diameters by Westlake Plastic Co. The plates are 36 inches in diameter and ¾-inch thick, with each plate having 7000 holes drilled precisely for location. Hole sizes range from 3/16 to 13/16 inch in diameter, and are made with drills and equipment designed to eliminate the burrs which result from conventional methods. The materials used for the plates have high strength-to-weight characteristics, resist corrosive chemicals and, even after exposure to radioactive conditions, retain their basic properties.

Look at this Size Range of Semi-Tubular Rivets... it's the way to lower cost



Miniaturized components and also large complete assemblies can now have all the money-saving advantages of using single and multiple automatic riveting. This is due to the wider size range of semi-tubular rivets now available and which can be used in conjunction with motor and pneumatic driven automatic riveting machines.

Today, there is hardly a fastening problem, involving even fragile materials, that does not warrant consideration of low-cost semi-tubular rivet setting.

Our Factory Riveting Specialists are ready to help you obtain the REAL COST FACTS on your own specific fastening problem. There is no obligation.

FOR YOUR FILES
Chicago Rivet Catalog describes 1388 standard tubular and split rivets and 25 single and multiple automatic rivet setters.

AIR-POWERED RIVETING
contains description and specifications of 8 single, multiple riveters— also rivet setters designed for automated operation.

Chicago Rivet & MACHINE CO.
943 So. 25th Ave., Bellwood, Ill. (Chicago Suburb)
Branch Factory: Tyrone, Pa.

Circle 663 on Page 35

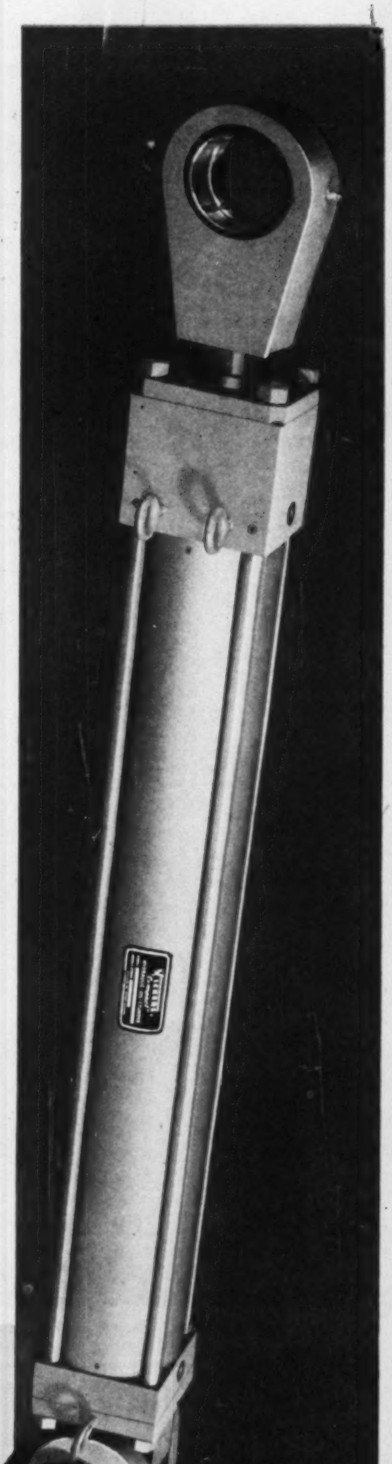
You get these benefits . . .

- prompt delivery
- competitive pricing
- any external mounting to meet your requirements

When you BUY

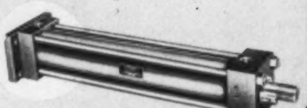
VICKERS HYDRAULIC CYLINDERS

Typical of custom designs that can be furnished readily from Vickers new cylinder facility is this model built with extra rigidity and strength at both rod and clevis ends to overcome side loadings. For added corrosion resistance, stainless steel clevis pins, piston rods, retaining screws and grease fittings are used. ▶



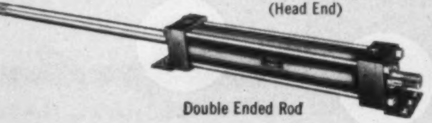
Standard Models for Operation to 3000 psi

Foot (Bracket) Mounting



Flange Mounting (Head End)

Lug Mounting



Double Ended Rod

Choose the cylinder "outside" that's best for your installation—Vickers offers you a wide selection of standard mountings plus an almost unlimited range of special configurations. Alternate rod end threads . . . straight thread port connections . . . extra barrel lengths for bearing support . . . are among many available options.

- Working pressures to 3000 psi (non-shock)
- Hard chrome plated, ground and polished, high-strength alloy steel piston rods.
- Large ports hold pressure drop within desirable limits.
- Fast, accurate parts replacement is assured because all cylinders are individually registered.
- Honed barrels of heavy walled seamless tubing minimize friction and wear.
- Cushions can be provided—either head, rod or both ends.
- Your choice of automotive step-cut piston rings for maximum life or low friction "T" rings for applications requiring minimum leakage. Full size cast iron piston for maximum bearing support with either type seal.
- Synthetic rubber wiper ring is standard—metallic wipers available.
- Two large wrench flats on rod are standard—additional flats available on request.
- Fully meet JIC specifications.

New, separate plant facilities—devoted exclusively to the design and manufacture of hydraulic cylinders—assure prompt individual attention to your orders. Service stocks are maintained at all Vickers warehouses in the U.S. and Canada. For more application data and installation dimensions, call or write today for Bulletin 60-68

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LOS ANGELES (Area)	ORegon 8-2503
MILWAUKEE	UPtown 1-0860
NEW YORK (Area)	DRexel 6-3500
PHILADELPHIA (Area)	LOwell 6-7900
PITTSBURGH (Area)	LOcust 1-3504
ROCHESTER	LOcust 2-5384
ROCKFORD	WOodland 2-0615
SAN FRANCISCO (Area)	ATlantic 4-7106
SEATTLE	MUtual 2-6950
ST. LOUIS	PArkview 1-4311
WORCESTER	SWift 8-3706

8903

Standard Models for Operation to 3000 psi

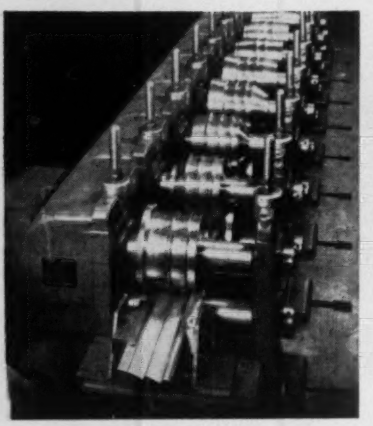
Flange Mounting (Rod End)

Extended Tie Rod Mounting

Trunnion Mounting (Intermediate Position)

Clevis Mounting

Trunnion Mounting (Rod End)



Yoder Roll-Forming Equipment mass-produces shapes accurately, economically

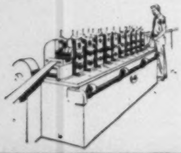
Yoder Roll-Forming Equipment, even with part-time operation, can effect significant savings in many metal working applications and industries. Shapes, simple or complex, can be quickly and economically produced the Yoder way from a wide variety of flat-rolled coated or uncoated stock ... in thickness up to ¾ inch ... in speeds up to 50,000 feet per day.

Yoder engineers flexibility and precision into metal forming operations. For example: many basic shape modifications, such as coiling, welding, notching, ring-forming, perforating, and cutting to length can be simultaneously accomplished with little or no-additional labor cost.

Yoder also makes a complete line of Rotary Slitters and Pipe and Tube Mills. Profit from Yoder's years of engineering and service experience, contact your local Yoder representative or send for the Yoder Roll-Forming Manual.

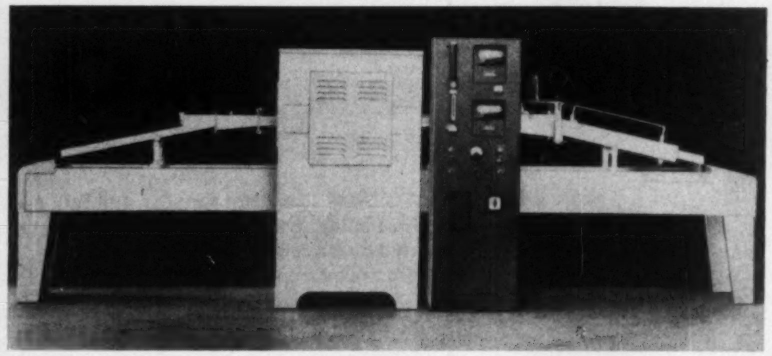
This fully-illustrated 88-page book clearly discusses every important aspect of Yoder Roll-Forming Equipment and methods ... it's yours for the asking!

THE YODER COMPANY
5526 Walworth Avenue • Cleveland 1, Ohio



ENGINEERING YODER MANUFACTURING
COLD ROLL FORMING MACHINES

Circle 665 on Page 35



AN APPLICATION that required high-temperature brazing under hydrogen atmosphere resulted in the development of a furnace whose physical configuration features an elevated heating chamber with inclined loading and unloading sections. The principal objective of the furnace, designed by C. I. Hayes Inc., was to minimize gases and impurities, and eliminate structural strains and distortion. Operating temperatures of 2050 F are held within critical tolerances through a saturable core reactor control system. Conveyorized work feed on a 3-inch belt provides high production rates with minimum handling.

detect erratic data, system malfunctions, and marginal conditions. In the event the check circuits detect an internal malfunction in the system, the operator will be informed and the alarms inhibited.

Other plans are to manufacture a 200-point temperature monitoring system to test the capabilities of the design on a process that requires reliable, round-the-clock monitoring for months at a time.

Arc Spot Welding For Aluminum

WELDING process has been improved so that it can be successfully used in the manufacture of aluminum products. As developed by Olin Mathieson Chemicals Corp., the process is a form of consumable electrode, inert gas shielded, metal arc welding suitable for spot welding of aluminum boats, shipping containers, window and door frames, and electronic components, and other items.

Welds are made from one side of the joint only, leaving the other side smooth, and cleaning of the base metal, as required for conventional resistance spot welding, is not necessary. The process is presently applicable to material more than 0.030 inch thick. In suitable applications it is expected to result in more rapid production, substantial labor and equipment savings, and improved product appearance.

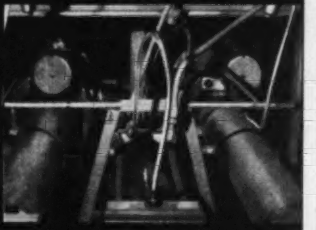
Technical procedures and test data will be made available to interested manufacturers. Standard equipment is obtainable from several equipment makers.

SPOTLIGHTING PEOPLE

Dr. William M. Mueller appointed assistant manager of manufacturing, Microwave Tube Div. and **Dr. Alan J. Rowe** named manager of research in the Industrial Dynamics Dept., both at Hughes Aircraft Co. . . . **Richard N. Close** appointed director, Apparatus Div., Airborne Instruments Laboratory . . . **C. E. Pritchard**, general superintendent of rolling mills for Alan Wood Steel Co. elected president of the Association of Iron & Steel Engineers. . . . **Robert M. Donovan** appointed factory manager, Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp. . . . **Dr. Erwin M. Koeritz** named manager of manufacturing, Metallurgical Products Dept., General Electric Co. . . . **R. J. Peters** appointed manager of product and market research and **M. W. Hott** named manager of engineering, both at OPW-Jordan Corp. . . . **Robert M. Lynas** appointed operation's manager of the Michigan Div. of Thompson Ramo Wooldridge Inc. . . . **Marlin P. Nelson** named assistant director of the Advanced Management and Methods Div. at Sun Oil Co. . . . **Charles B. Raybuck** appointed vice president for contract management and **Dr. Paul E. Ritt** named director of research, both at Melpar Inc. . . . **Kenneth E. Lewis** appointed plant manager at Detroit and **A. C.**

Where actuating control and precision are paramount

—like in a giant supersonic wind tunnel



—or a precision machine tool

you'll find "BEAVERS"

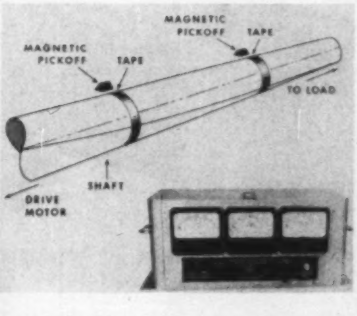
BEAVER ball screws are specified by engineers around the world for control of motion. Compressing solid steel wind tunnel walls, 1600 feet square against inconceivable pressures and holding error to .008" in an 8 foot stroke—or extreme accurate 3 dimension positioning of numerically controlled machine tool are all "naturals" for this equipment.

Can your product be made more efficient with Beaver Ball Screws? Write for literature.

Beaver Precision Products INC.
CLAWSON, MICH.

Circle 666 on Page 35

Prudner named plant manager at Youngstown for the Stainless and Strip Div. of Jones & Laughlin Steel Corp. . . . **Richard Miller** appointed manufacturing manager at Buhr Machine Tool Co. . . . **Robert G. Peterson** named assistant chief engineer of the Hydraulics Div., Racine Hydraulics & Machinery Inc. . . . **Reginald D. Schuler** appointed director of technology at Fischer & Porter Co. . . . **W. Frederick Goodyear** named manager of development and **Carl Greenblum** appointed manager of advanced development, both in the Engineering Dept. at Teleregister Corp. . . . **E. H. Woodberry,** assistant to the vice president, Lamson Corp., elected president of Conveyor Equipment Manufacturers Association. . . . **Thomas R. Bitterly** named manager of "304" electronic data processing centers at National Cash Register Co. . . . **Herbert D. DeBorde** appointed director of manufacturing for Burroughs Corp. . . . **Dr. Charles F. Robinson** elected vice president of Consolidated Electrodynamics Corp. . . . **Henry Reinecke Jr.** and **Richard W. Hofheimer** joined Non-Linear Systems Inc. as project managers . . . **Jay Schwalbe** appointed manager of manufacturing of Computer Measurements Co. . . . **Walter I. Shevell**



HORSEPOWER METER measures horsepower directly with no modification of an existing shaft. Shaft torsional deflection (a function of applied torque) and rotational speed are measured magnetically and are electronically multiplied to give horsepower. Horsepower, torque, and rpm are displayed on individual meters on the device, and are available as analog voltages. Mechanical followers are available to remove the effects of large radial and axial shaft motions. The meter is transistorized to supply stable, accurate system outputs. This meter has been utilized on shafts ranging from 0.5 to 23 inches in diameter, transmitting from 0.01 to 20,000 horsepower. Larger sizes can be accommodated. Meter was developed by Sierra Research Corp.

BEAVER BALL SCREWS

Successor to the Acme screw drive and preferred in many applications to hydraulic and pneumatic systems. Guaranteed 90% efficient in converting rotary twist to linear push (or vice versa). Employs a stream of precision balls and ground lead to eliminate drag and wear in delicate instruments, aircraft, machine tools, massive wind tunnel jacks, etc. For horizontal and vertical actions, indexing, inching and traversing. Consultation and engineering service available. Write for literature.

• EXTREME ACCURATE POSITIONING • NO BACKLASH • RAPID START • ANY DIAMETER OR TRAVEL •

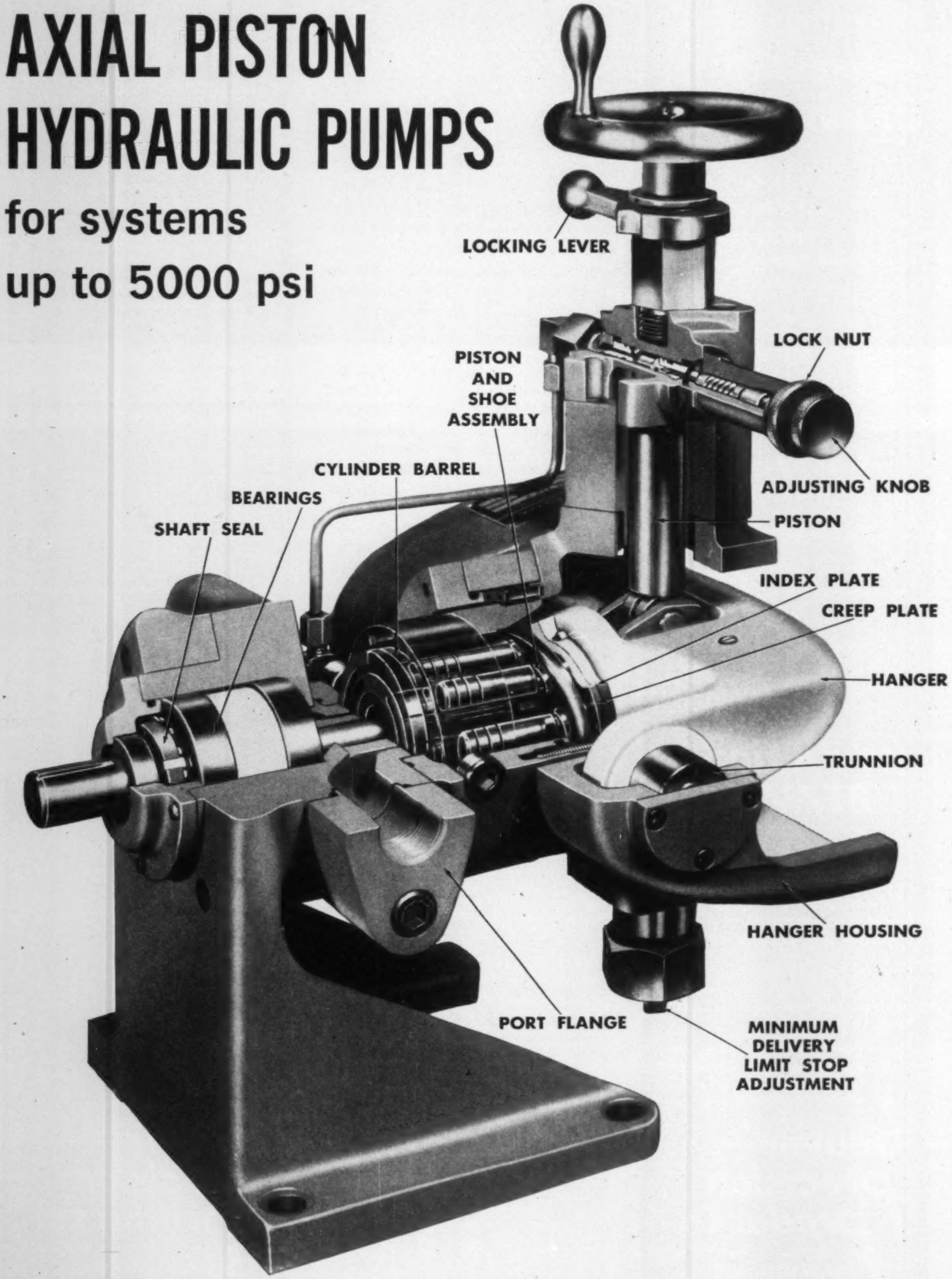
Beaver Precision Products INC.
CLAWSON, MICH.

Circle 667 on Page 35

Design of variable volume

AXIAL PISTON HYDRAULIC PUMPS

for systems up to 5000 psi


LOCKING LEVER
LOCK NUT
PISTON AND SHOE ASSEMBLY
ADJUSTING KNOB
CYLINDER BARREL
BEARINGS
SHAFT SEAL
PISTON
INDEX PLATE
CREEP PLATE
HANGER
TRUNNION
HANGER HOUSING
PORT FLANGE
MINIMUM DELIVERY LIMIT STOP ADJUSTMENT

By: Ellis H. Born
Director of Sales-Engineering
Denison Engineering Division
American Brake Shoe Co.
Columbus, Ohio

With today's ever-increasing requirements in the transmission of higher horsepower, the designer must look to hydraulic components that will give the greatest transmission efficiency with the lowest possible cost and the smallest possible package. With smaller, lighter, more powerful equipment—operating pressures of 2000, 3000 and 5000 psi are becoming commonplace. To meet the needs of higher pressures with a high degree of reliability, axial piston pumps and motors of proper design should be considered.

For 5000 psi requirements, the axial piston pump (illustrated) is a logical choice. It operates on the principle of a series of pistons in a common barrel that progressively draw oil into the barrel on the suction stroke and force oil from the barrel into the line on the discharge stroke.

With this simple axial piston design, direct and unrestricted flow into the pumping assembly is possible, eliminating the need for the large flow areas used and the moving seals which, in turn, eliminates maintenance. Direct flow path further insures good suction characteristics—a highly desirable operating advantage for obtaining efficient hydraulic performance.

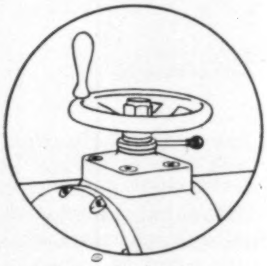
The port plate of the Denison pump is designed as an axial hydrostatic bearing which balances out the thrust of the cylinder barrel, leaving only sufficient force to create a positive seal contact between the cylinder port plate and the cylinder barrel. Because of reduced thrust, wear on mating surfaces is decreased and pump life is greatly extended at all pressures up to 5000 psi.

Where variable volume is required, it is logically desirable (for efficiency, simplicity and low maintenance) to eliminate the need for varying the position or angle of the cylinder barrel to regulate volume. In the Denison axial piston pump, output up to 125 gpm is simply regulated by varying cam plate angle. Zero to full flow or flow reversal is regulated by handwheel, hydraulic cylinder, stem, electric motor, compensator or electrohydraulically.

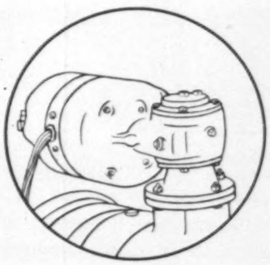
In the Denison design, the line of action of the combined radial load of all pistons is through the roller bearing supporting the cylinder barrel. The use of a large bearing provides non-deflecting support for these radial forces. As a result, unbalanced or twisting offset that would tend to unseat the cylinder barrel from the port plate is eliminated. A continuous, effective sealing action of the barrel against the port plate is maintained to promote high pumping efficiency.

Piston and shoe assembly design also reduces by one-half the number of ball and socket couplings found in other types of axial piston pump construction. The shoes hydraulically balance out all piston thrust, eliminating need for thrust bearings.

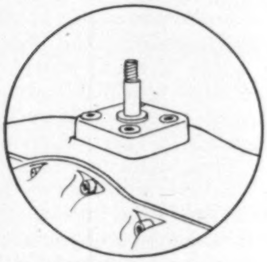
Data and specifications on 5000 psi pumps, motors and controls are available from your Denison representative—located in principal cities—to assist you in developing hydraulic systems for maximum efficiency and economy.



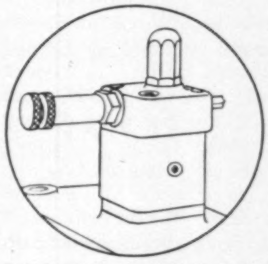
HANDWHEEL CONTROL
. . . with locking device for accurate manual pump volume regulation.



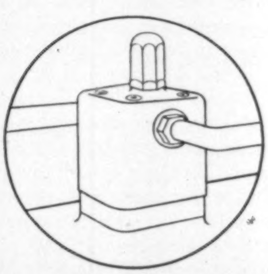
ELECTRIC MOTOR CONTROL
. . . adjusts pump volume to desired level. Integral brake in gear-head motor eliminates over-travel.



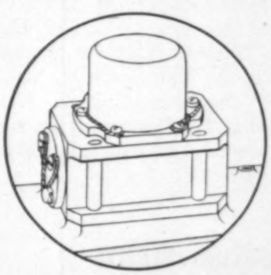
STEM CONTROL
. . . provides mechanical linkage to the driven equipment.



PRESSURE COMPENSATOR CONTROL
. . . affords automatic regulation of pump volume to meet preset pressure demands.



HYDRAULIC CYLINDER CONTROL
. . . similar to stem control, except volume is hydraulically regulated.



ELECTRO-HYDRAULIC CONTROL
. . . utilizes sensitive, system error-detecting unit which energizes hydraulic volume control piston.

NEW CATALOG
FOR DESIGNERS
AND ENGINEERS

Write for your copy of Bulletin 220—"Hydraulic power to 5000 psi". Includes complete specifications, operating data and applications for Denison's full line of hydraulic pumps, motors and controls.

DENISON ENGINEERING DIVISION
American Brake Shoe Co.
1234 Dublin Road • Columbus 16, Ohio

Circle 668 on Page 35

AIR-HYDRAULICS
INCORPORATED

NEW TABLE

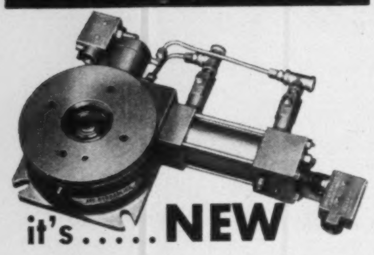
HANDLES UP TO
ONE TON

Index 30 positions per minute when equipped for 6 station operation with Air-Hydraulics' new Model 2400 (24" dia.) air index table • Handles work loads up to one ton • Bolt larger diameter plates to 1¼" ground steel table top for greater table area • Repetitive shock loads are no strain • 4" bore index cylinder develops power stroke 13 times line pressure for extra power and speed—no override • Adjustable cushion and speed control • Locking cylinder, mounted on table's centerline, means positive index every time— =.0015" • Limit switch keeps basic equipment from moving until table is "locked in" • Pressure lubrication, tapered roller bearing on shaft and ample bearing surface at circumference assure friction free operation • Operates on 60 to 175 psi line pressure • 4, 6, 8 or 12 stations with clockwise rotation standard • Others, including counterclockwise rotation, and from 3 to 60 positions to order.

WRITE NOW FOR CATALOG AND PRICE INFORMATION

AIR-HYDRAULICS
INCORPORATED

LOW COST
7" INDEX TABLE



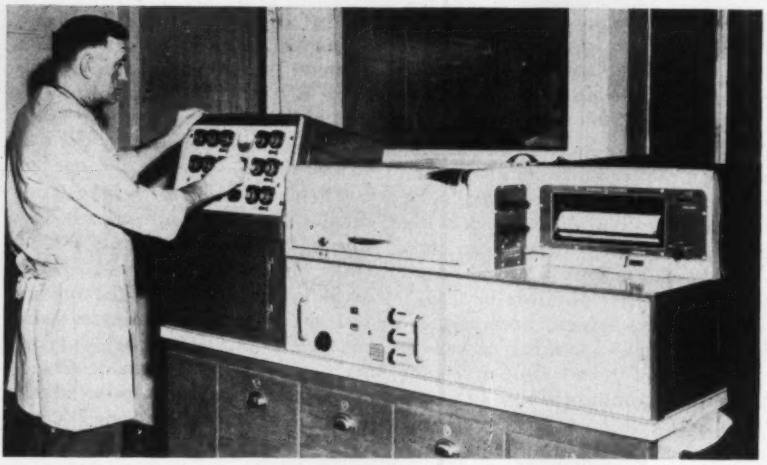
it's.....NEW

The heavy duty Model 700 is only 7" in diameter but has most of the features found on larger models • Makes up to 75 indexes per minute • Handles maximum work load of 100 lbs. • Maximum power stroke is 3 times line pressure • Operates on pressures from 60 to 175 p.s.i. • Clockwise rotation with either 4, 6, 8 or 12 stations standard • Others up to 24 stations and counter-clockwise rotation, to order • Bolt larger sub-plate (up to 14" dia.) to ground steel table for larger work area • Positive index—no override • Adjustable cushion and speed control • Each table checked for guaranteed accuracy of index (± .0015"), concentricity and parallelism.

WRITE NOW FOR FREE CATALOG AND PRICE INFO.

AIR-HYDRAULICS
INCORPORATED
299 HUPP AVE.
JACKSON, MICHIGAN

Circle 669 on Page 35



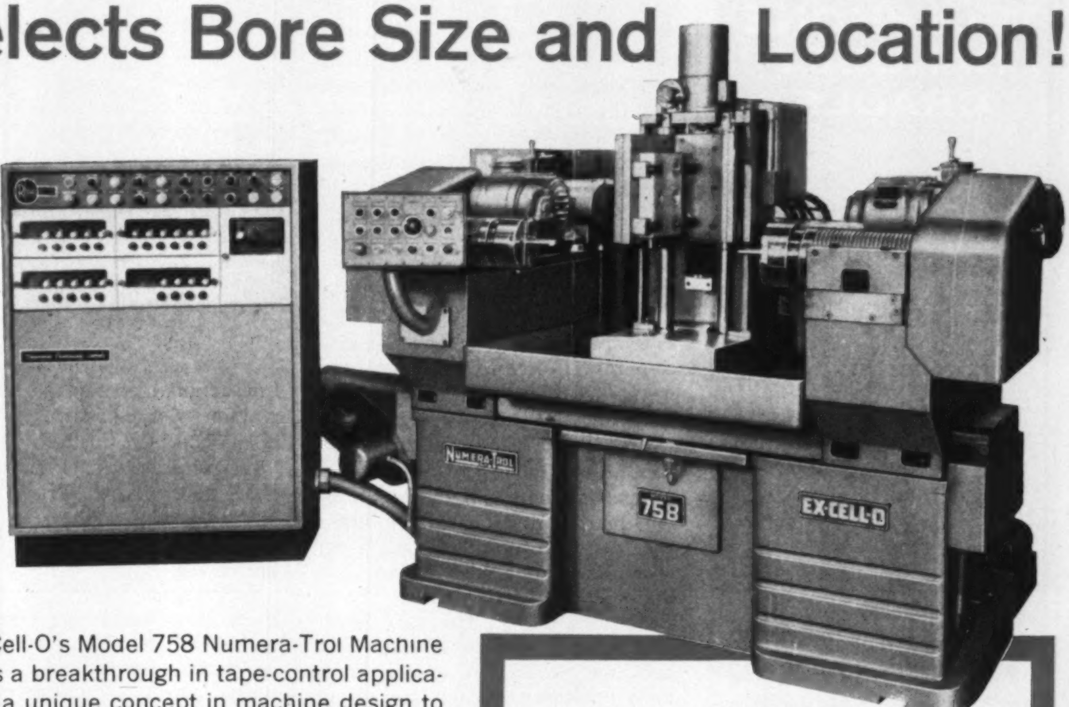
ELECTRONIC COLOR measurement system accurately matches colors of styrene molding compounds from customer's samples. Unit consists of a recording spectrophotometer (right) made by General Electric Co. and a colorant mixture computer (left) made by Davidson and Hemmendinger. The spectrophotometer measures the color characteristics of the sample. The formula for a production run is then calculated with the computer. As the spectrophotometer analyzes the color of the material, it automatically produces a graph of reflectance versus wave length, which becomes a permanent record for file. If the original sample fades or is lost, the user, Monsanto Chemical Co., can prepare an exact color duplicate from the data.

elected vice president of Giannini Controls Corp. . . . **Seymour R. Cray** named director of development and **R. N. Kisch** named director of operations, both in the Computer Div. of Control Data Corp. . . . **Dr. Juls Miller** appointed head of the new Electromagnetic Devices Dept. at Schaevitz Engineering . . . **George G. Brooks** named director of industrial systems at Consolidated Systems Corp. . . . **Leonard C. Marsac** elected president and member of the board of directors of Diehl Mfg. Co. . . . **George Loeffler** joined Thomas Engineering Co. as director of engineering . . . **Alan M. Brown** named president and **Bernard Klibaner** named vice president in charge of engineering and manufacturing of Electro-Mechanical Corp. . . . **Lindsey M. Hobbs** appointed manager of central research at Lord Mfg. Co. . . . **Herbert R. Reiss** named manager of the New Rochelle, N. Y. plant of Precision Circuits Inc. . . . **Thomas H. McConnell Jr.** appointed president of Packaging Materials Corp.

SPOTLIGHTING PLANTS

Daystrom Inc. has acquired the assets of Wiancko Engineering Co., manufacturer of sensing instruments. It will operate as an independent subsidiary and will be known as Daystrom - Wiancko Engineering Corp. . . . **Filtors Inc.**, manufacturer of subminiature and microminiature relays has leased an additional 5200 sq ft which will be used for engineering facilities. . . . **Industrial Management Consultants** is the name of a new organization which will aid management in the planning and design of plant, management organization, and manufacturing equipment and methods, with special emphasis on cost reduction. . . . **Datex Corp.** announces the formation of a new servomechanism group. The new unit will be responsible for the design of precision servo systems, servo repeaters, and special purpose analog computing equipment for industrial control. . . . **Infrared Industries Inc.** and **Cramer Controls Corp.** have reached an agreement to combine, subject to approval by the directors and stockholders of each company. Cramer Controls will operate as a separate division or subsidiary of Infrared Industries and provide a broad range of controls for the application of infrared techniques. . . . Purchase has been made of 41 acres of land in Clinton, Conn. to build a wire mill for Universal Wire Co., subsidiary of **Bostitch Inc.** The new plant will produce a substantial part of the

New NUMERA-TROL Automatically Selects Bore Size and Location!



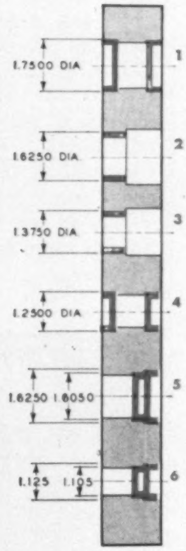
Only Ex-Cell-O's Model 758 Numera-Trol Machine combines a breakthrough in tape-control application with a unique concept in machine design to give you these exclusive production capabilities:

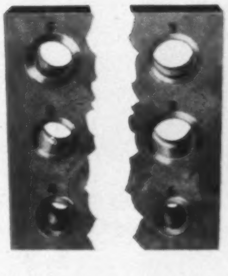
- Automatic pre-selected bore diameter control during machine cycle
- Automatic work positioning for infinite center locations
- Automatic straight-boring, step-boring and counterboring from either end of machine

Using interchangeable boring bars which respond to tape control through a new mechanism developed by Ex-Cell-O, the Model 758 Numera-Trol lets you program variable bore diameters. (Tools are available giving an infinite range of diameters in one-inch increments.) Bore diameters are controllable within .0005", bore depth is controllable to plus or minus .0005".

Infinite bore locations, accurate within .0002" of true center, are possible within the Model 758's 10-inch cross slide and vertical slide strokes.

Infinite, too, are the Model 758's applications. Your Ex-Cell-O Representative can give you complete details, or write direct for Bulletin 506015.





On this workpiece, tape-controlled sequence is programmed from largest to smallest diameters; automatic boring bar adjustment is made at the end of each stroke to eliminate drawback lines. Model 758 holds concentricity within very close tolerances.

60-84

EX-CELL-O FOR PRECISION

PRECISION MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • TORQUE ACTUATORS • CONTOUR PROJECTORS • GAGES AND GAGING EQUIPMENT • GRANITE SURFACE PLATES • COMPUTER PRODUCTS • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • ATOMIC ENERGY EQUIPMENT • DAIRY AND OTHER PACKAGING EQUIPMENT

Machinery Division

EX-CELL-O
CORPORATION
DETROIT 32, MICHIGAN

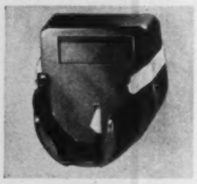
Circle 670 on Page 35

NEW
STROMBERG-CARLSON
TELEPHONE
HANDSET
CRADLE

... for positive retention in all mobile applications

There's no jump, no sway—when a telephone handset is in the firm grip of this new handset cradle by Stromberg-Carlson.

Retaining clip spring assembly assures positive retention in any mobile application on land or sea, or in the air. Even extremely severe jars, jolts and vibrations fail to dislodge the handset.



The cradle is strong and resilient, fits any Stromberg-Carlson handset. Different models provide varying switch combinations with 2 or 4 Form C contacts. All models available with or without the clip assembly.

Specifications on request. In Atlanta call TRinity 5-7467; Chicago: STate 2-4235; Kansas City: HArrison 1-6618; Rochester: HUbbard 2-2200; San Francisco: OXford 7-3630. Or write to Telecommunication Industrial Sales, 111 Carlson Road, Rochester 3, New York.

STROMBERG-CARLSON
A DIVISION OF
GENERAL DYNAMICS

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company's requirements of stapling wire and attaching wire. . . . **Ohio Forge & Machine Corp.** has purchased Cleveland Punch & Shear Works Co., manufacturer of mechanical power presses, fabricating machines for structural steel and steel plate, and punching tools and dies. It will be operated as a subsidiary of Ohio Forge under its present name. . . . **Hewlett-Packard Co.** has formed a Precision Components Div., with headquarters at the main plant in Palo Alto, Calif. The new division will develop and manufacture precision components used in electronic instrumentation. . . . **Hurletron Inc.** is the name of a new corporation formed through the merger of Electric Eye Equipment Co. and Wheaton Engineering Corp. Both firms, which manufacture electronic and mechanical components and automatic controls, will become divisions of Hurletron Inc. . . . **Carpenter Steel Co.,** Webb Wire Div. has started construction on a 50,000 sq ft plant at North Brunswick, N. J. The new plant will house a modern wire drawing mill for production of the company's precision stainless steel spring wire, needle wire and nickel alloy, electrical, and low expansion wires. . . . **Louis Allis Co.** has purchased Dynapar Corp., manufacturer of custom electronic equipment such as preset digital controllers, length controllers, speed indicators, and transducers. This line of equipment will be marketed as a separate and distinct product line, but will also be in conjunction with the adjustable speed drive equipment manufactured by Louis Allis to provide a more complete line to those who use automated processes.

MEETINGS AND EVENTS

Jan. 9-11—

Symposium on Reliability and Quality Control. Seventh national symposium sponsored by IRE, AIEE, EIA, and ASQC. To be held at Bellevue-Stratford Hotel, Philadelphia. Additional information from R. E. Kuehn, Institute for Defense Analysis, Pentagon, Washington, D. C.

Jan. 9-13—

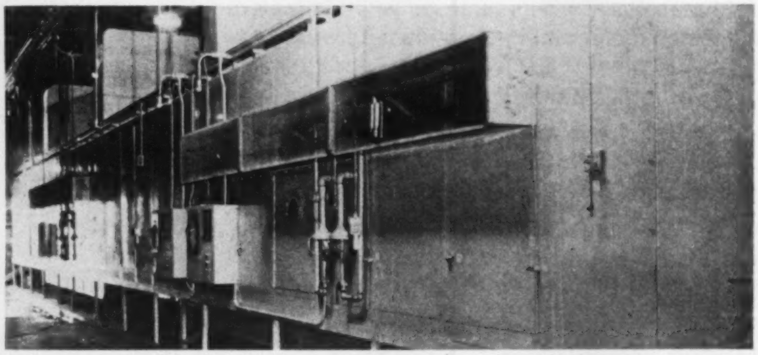
Society of Automotive Engineers. International congress and exposition with 500 displays. To be held Cobo Hall, Detroit. More information from society headquarters, 485 Lexington Ave., New York 17, N. Y.

Jan. 17-19—

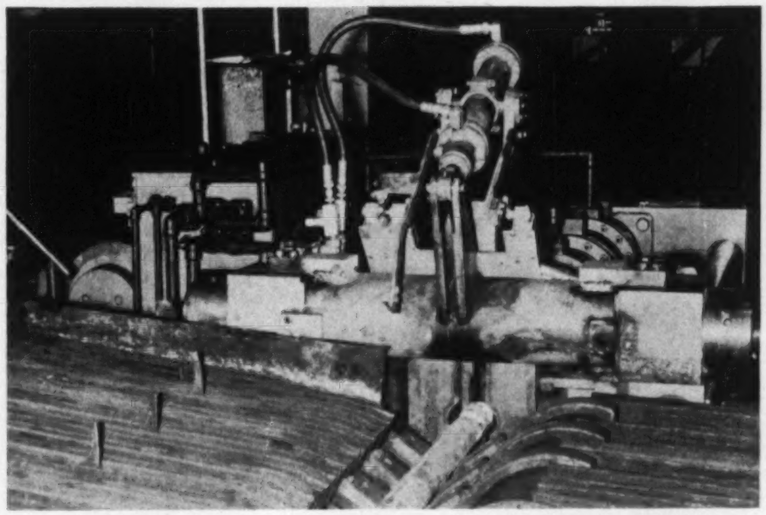
Instrument Society of America. Instrument-Automation conference and exhibit of measurement devices, computers, components, and electronic controls. Conferences will be in the Sheraton-Jefferson Hotel and the exhibit at Kiel Municipal Auditorium, St. Louis. Additional information available from society headquarters, 313 Sixth Ave., Pittsburgh 22, Pa.

Jan. 23-26—

Plant Maintenance and Engineering Show. Conferences on both managerial and technical aspects of maintenance and exhibits of more



SETUP for dehydrating onion pieces employs a continuous stainless steel conveyor belt to move products through multiple warm air chambers. Developed by Gentry Div., Consolidated Foods Corp., the unit features automatic control of temperature, humidity, and exhaust rate for air in each chamber. In-transit time of products through the unit is controlled by varying the speed of the conveyor.



HYDRAULIC billet centering machine, built by Lombard Corp., accurately places center holes in the ends of alloy steel billets with diameters up to 7 inches. Production rate is up to 5 billets per minute. The center hole facilitates the ease of entering a billet into rotary piercing rolls and reduces shell crop losses by improving the concentricity of the starting ends of shells produced on the piercing mill. The machine is designed so that only the work end of the billet is gripped while a hole is being formed. After the billet has been moved between gripping jaws, a hydraulic cylinder automatically closes the jaws and moves a centering tool into the billet. The tool and gripping jaws are then retracted and the billet is ejected from the unit.

than 10,000 products. To be held at the International Amphitheatre, Chicago. Additional information from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

Jan. 24-27—
Society of Plastics Engineers. Annual technical meeting. To be held Shoreham and Park-Sheraton Hotels, Washington. Additional details available from society headquarters, 65 Prospect St., Stamford, Conn.

Jan. 26-28—
Symposium on Instrumentation For the Process Industries. Sponsored by Texas A & M College. To be held at College Station, Texas. More information available from Pan-Tech Engineering Co., 3783 Richmond Ave., Houston 27, Tex.

Jan. 29-Feb. 3—
American Institute of Electrical Engineers. Winter general meeting to be held New York. More information from institute headquarters, 33 West 39th St., New York 18, N. Y.

Feb. 7-9—
Society of the Plastics Industry Inc. Reinforced plastics division conference to be held at Edgewater Beach Hotel, Chicago. More details from society headquarters, 250 Park Ave., New York 17, N. Y.

Feb. 9-11—
National Society of Professional Engineers. Winter meeting to be held at Hotel Fort Des Moines, Des Moines. Additional information from society headquarters, 2029 K St., N. W., Washington 6, D. C.

AUTOMATIC COMPUTER

AUTOMATION

"I don't know how you're supposed to refer to it, but I usually call it a she—I've never been able to overfeed it."

How to use
FLUID POWER
✓ efficiently
✓ economically
is as easy as . . .
A B C
when you specify
PROVEN QUALITY SP CYLINDERS • BOOSTERS

SERIES A
Standard Cylinders AIR or OIL Without Modification
Save money with S-P's complete line; rated 200 psi air, 500 psi oil or water; 23 mounting types; 11 bore sizes—1½" thru 14"; see Catalog 110C.

SERIES B
HIGH PRESSURE Hydraulic Cylinders
Get smoother, more precise power; ruggedly built, interchangeable; 2000 psi (3000 psi non-shock); 12 bore sizes—1⅛" thru 12"; get Catalog 117.

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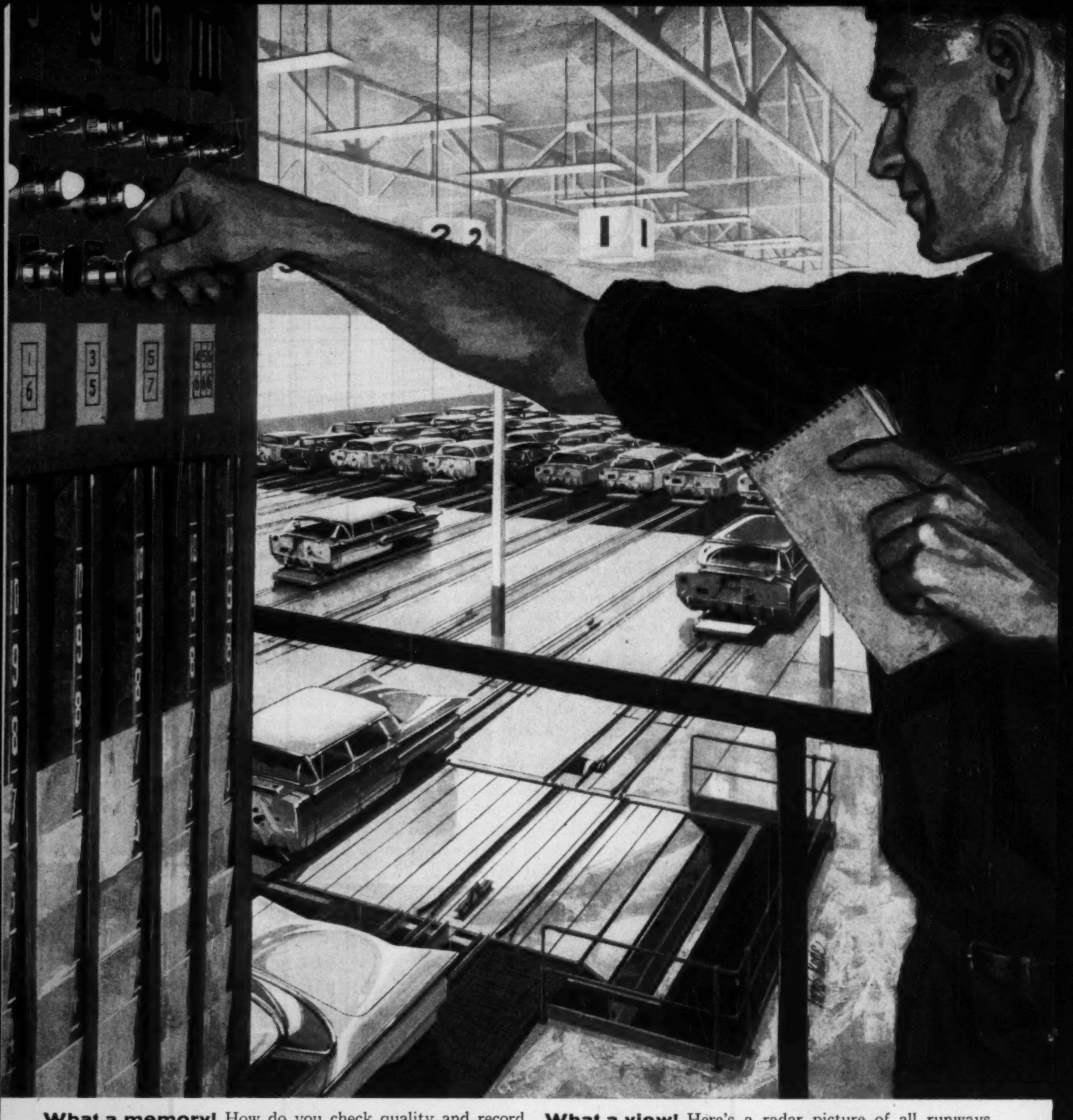

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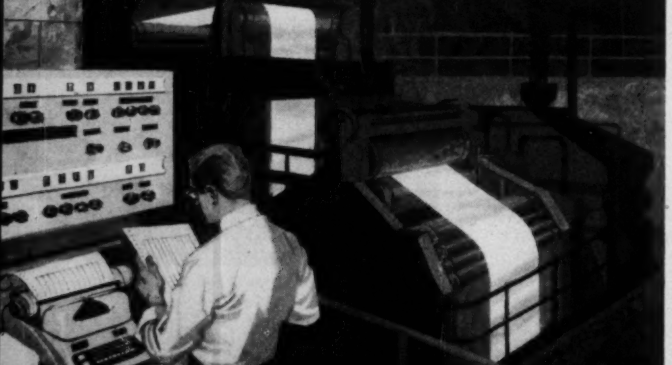

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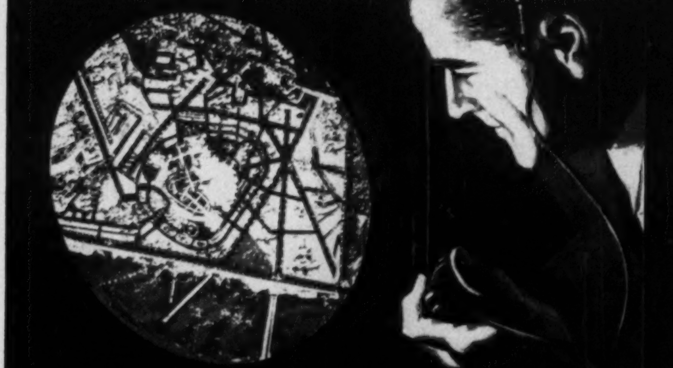

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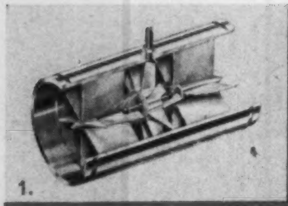
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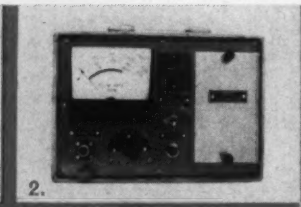
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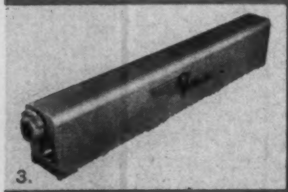
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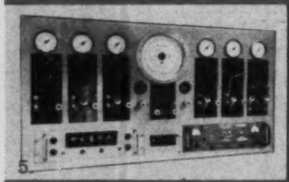
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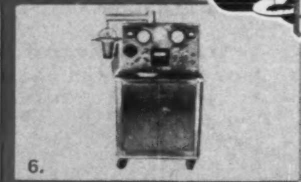
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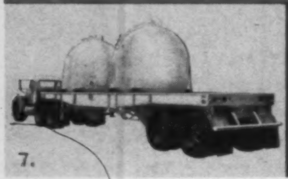
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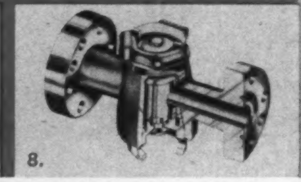
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SPECIAL PRODUCTS DIVISION

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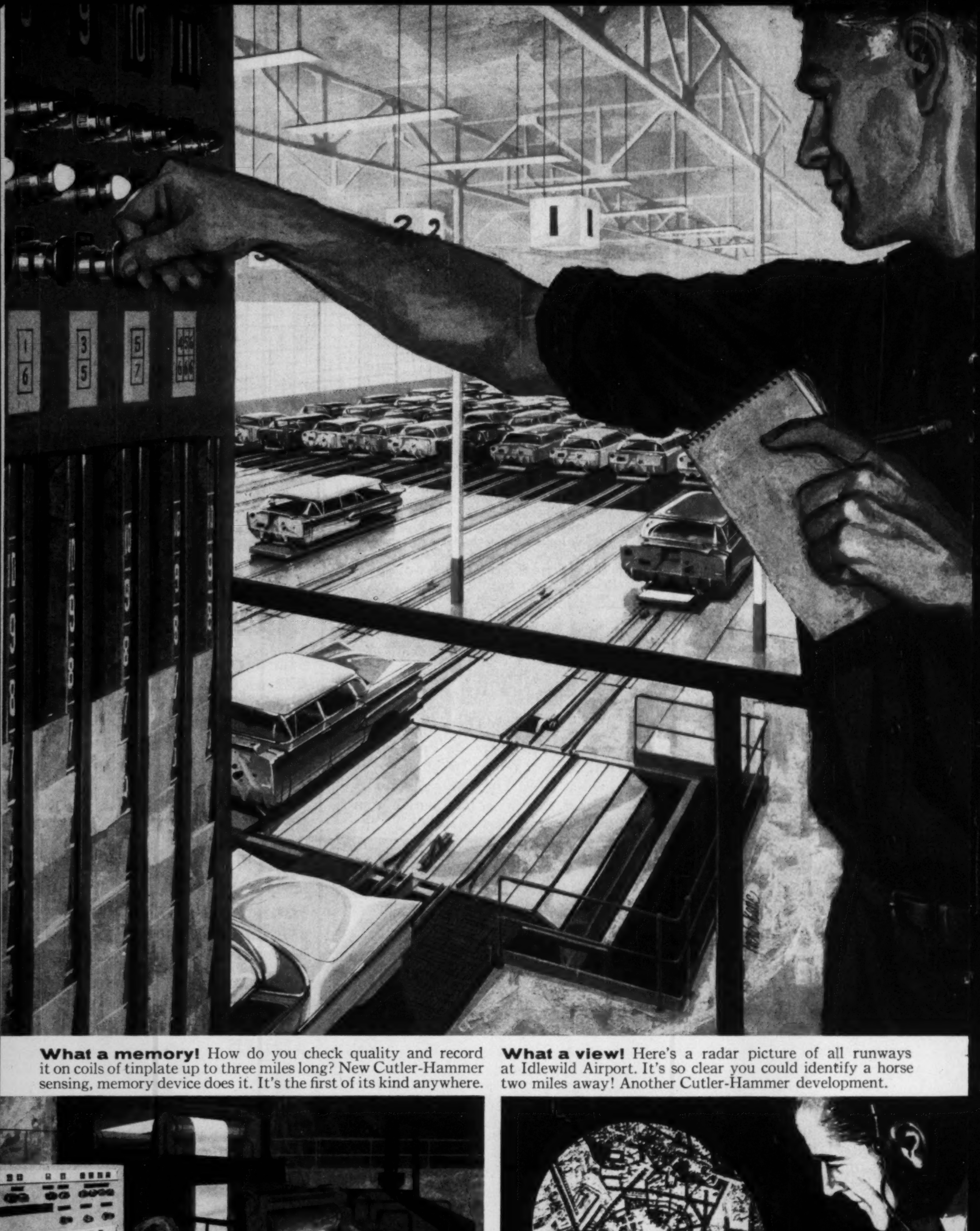

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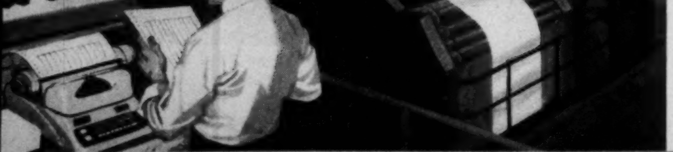

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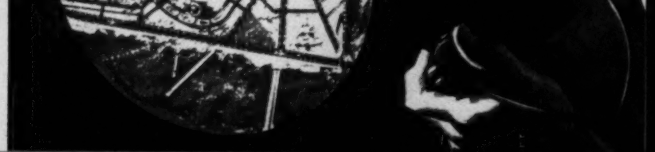

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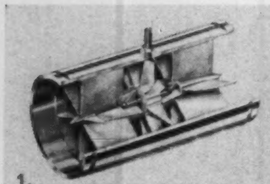
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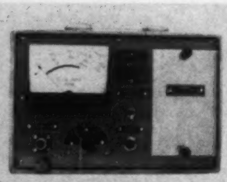
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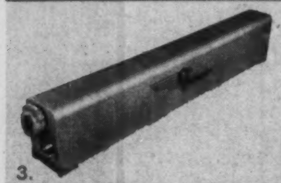
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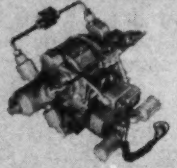
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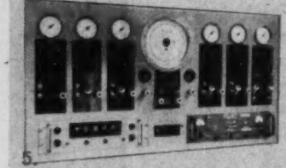
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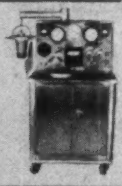
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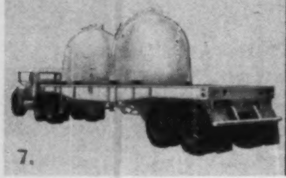
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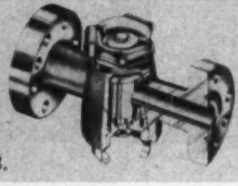
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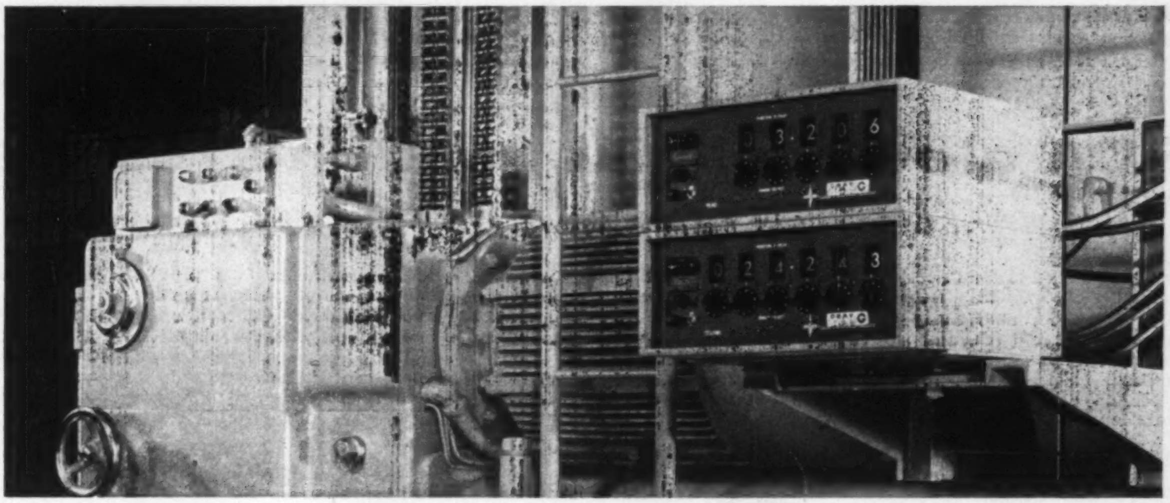
NORDEN Modumatic Control for New and Existing Machines

Series 100 features

- Actual Position Readout
- Decimal Display
- Full Range Origin Select



IF you have the time-consuming problem of rotary or linear positioning, then you are aware of the importance of knowing the exact location of the tool or the work piece. Up until now this was a tedious, time-consuming process requiring calculation and dial reading, both subject to human error. Norden's Series 100 display system eliminates all this and performs the calculations automatically. What's more, it can be installed on **new** and **existing** machines.

The Series 100 numerical control system utilizes a unique position feedback transducer, electronic circuitry and a visual display to indicate the **actual** position of the tool or work piece.

The **actual** position is displayed in straight decimal form by illuminated numbers that are readable from twenty feet. The display unit may be located on the machine or remote.

This Norden Modumatic system also offers a full range electronic origin select so that any desired offset can be quickly and easily dialed in by the operator on manual selector switches.

For more information about this position display system or other Modumatic control systems contact your nearest Norden Representative—400 Main Street, East Hartford, Connecticut, JAckson 8-4811, 11 West Monument Ave., Dayton 2, Ohio, BAldwin 8-4481, or write to us at the address below.

A new concept in Numerical Control
from **NORDEN** DIVISION OF UNITED AIRCRAFT CORPORATION
DATA SYSTEMS DEPARTMENT
COSTA MESA, CALIFORNIA

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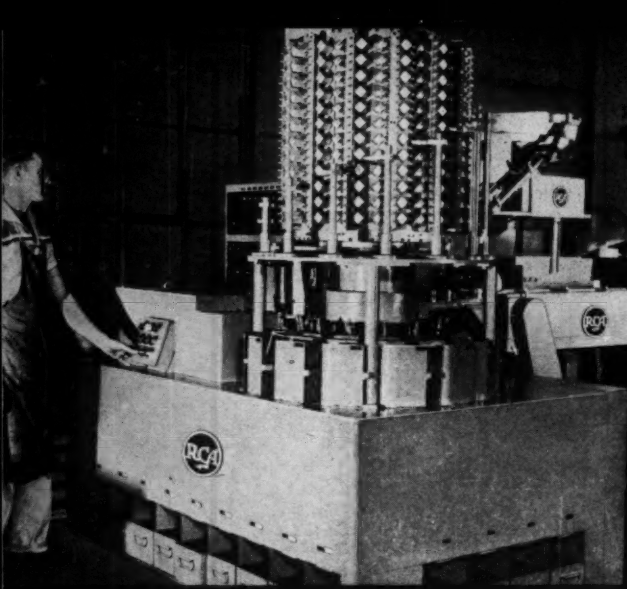
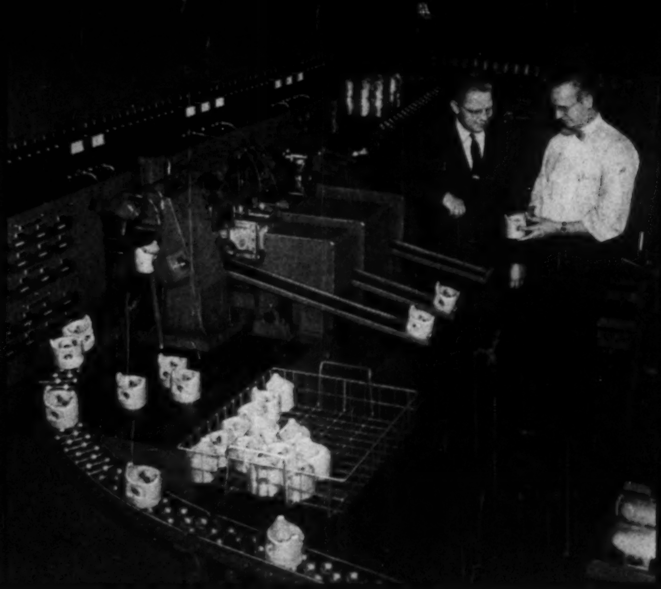


GAGING—Roller Bearing Inspection Machine gages O.D. and segregates roller bearings into 8 acceptable categories in increments of .0001", as well as over and under size. Capable of rates in excess of 15,000 parts per hour.



FINAL INSPECTION—Piston Checking Machine inspects up to 2600 4" to 4⅛" diameter pistons per hour fed at random. Inspects O.D., I.D., length, taper, true roundness. Segregates into 12 acceptable classifications, plus over and under, and automatically counts and totalizes.

RCA electronic inspection systems

First Choice for Reliability, Accuracy, High-Speed Operation

To meet today's critical needs for reliability, many leading companies are switching from statistical quality control to RCA's 100% automatic inspection systems. Illustrated are only a few of the "proved in use" gaging, testing and inspection systems available. With these high-speed systems, increases in production rates up to 800% over manual inspection have been reported, with superior reliability and accuracy.

Whatever your requirements . . . a fully integrated automation system, or simple mechanization of individual operations, RCA Industrial Controls offers the most versatile range of such equipment available from any source.

For details, contact your nearest representative, or write to RCA Industrial Controls, 12611 Arnold Avenue, Detroit 39, Michigan.

RCA The Most Trusted Name in Electronics

RADIO CORPORATION OF AMERICA

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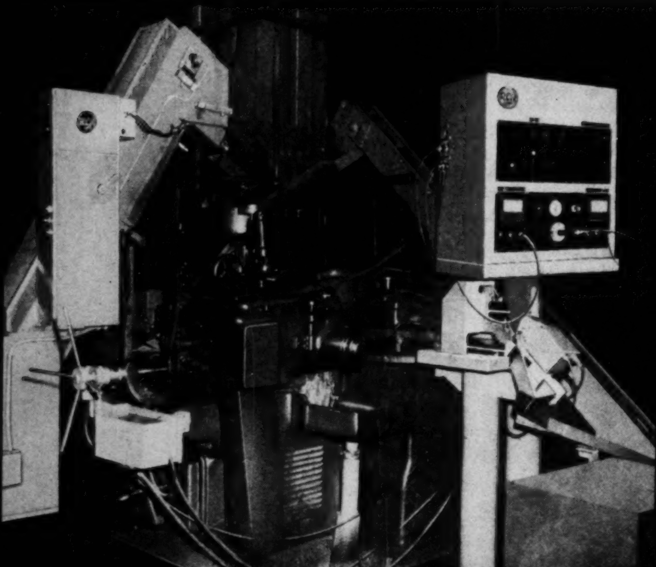
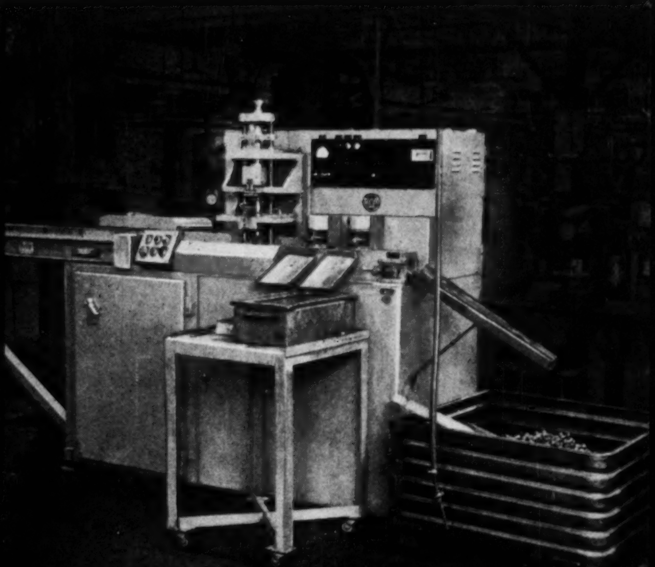
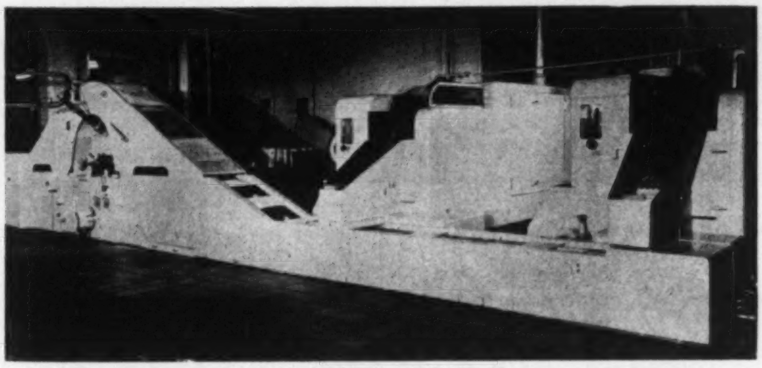
GRINDING CONTROL—Self-compensating Centerless Grinder Control assures production of consistently uniform parts. Corrects grinder automatically in increments of .000025". Can be used for rough or finish operations. Extreme reliability and 100% repeatability.



HARDNESS TESTING—Automatic High-Speed Hardness Testing Machine inspects up to 2500 parts per hour with laboratory accuracy. RCA Superficial type Hardness Tester capable of inspecting up to 6,000 parts per hour is also available.



international scene



Glasgow, Scotland—Production of multilayer, chocolate coated sugar wafers is carried out efficiently at Gray Dunn & Co. Ltd. with special automatic equipment developed by Baker Perkins Ltd. With system shown, batter is formed into wafer sheets in two gas-fired ovens, right, and discharged onto collecting conveyors. As they move to filling and sandwiching unit, left, one of every four wafer sheets is diverted to overhead conveyor. Other three sheets receive cream filling in lower section. The four sheets are then assembled into sandwiches, with bypassed dry sheet on top, in final section of machine. After cooling, sandwiches are cut into rectangles in two operations at right angles. Products are then collected, passed through chocolate coater, and placed on plaques. After cooling, coated products are wrapped automatically on Forgrove packaging machines. Output of system is 13 tons of finished products per 22½-hour operating period.

Progress in Sweden

SOME ADVANCES in automation over the last few years in Sweden were reflected in two exhibitions held recently in Stockholm. One of the shows was devoted to basic and institutional research. The other event, which attracted exhibitors representing some 400 manufacturers throughout the world, offered an interesting display of instruments and apparatus for process control and other industrial uses.

Among the new Swedish products introduced was a desk-top size digital computer developed by Saab Aircraft Co., Linkoping. The unit, designated Saab D2, can be used for chemical and industrial process control, reactor control, and ground testing of missiles and aircraft systems. For applications such as process control, built-in analog-digital and digital-analog converters are provided.

The transistorized computer has two ferrite core stores, one for instructions and the other for data. Maximum internal core store capacity is 4096 words. However, when large volumes of data are to be processed, an external store such as the company's Saraband magnetic tape system can be used to increase the memory capacity. With an external system, the added capacity of up to eight tape recorders (each storing 524,288 words) is available through a central control unit. A program interrupt feature allows the system to control several peripheral units for search, read, and write while the computer processes the data.

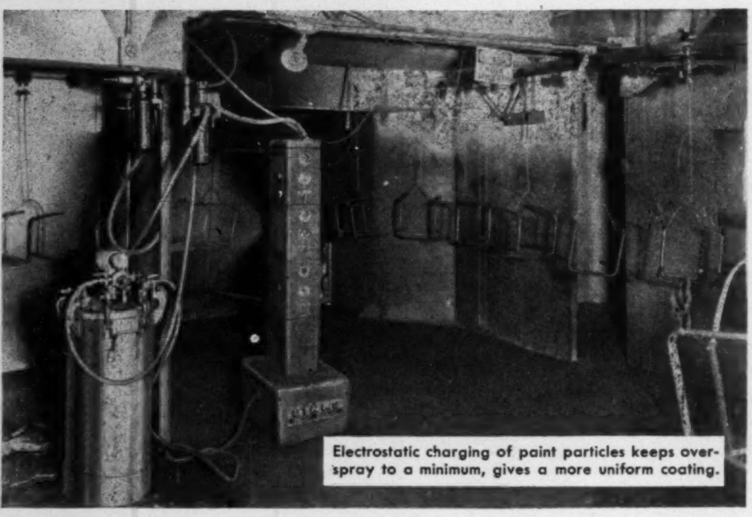
Facit, Sweden's largest office machine manufacturer, has been operating a large electronic computation and integrated data processing center. This company presented two new auxiliary units. One is a transistorized, high speed tape punch with a punching speed of 150 lines per second. The other unit is a transistorized dielectric tape reader that can read 500 lines per second.

Another device attracting attention was a product called a conductolyzer, used for continuous measurement of electrical resistance in flowing solutions. The conductolyzer is manufactured by the Stockholm firm of LKB-Produkter.

AB Electrisk Malmletning (ABEM) presented an inkless, direct-writing recorder that uses heated pens registering on wax-covered, lined paper. Available either as a 5 or 12-channel unit, the recorder includes an oscillograph fitted with highly sensitive coil galvanometers that are capable of recording dc and ac signals to 1.5 cps. The unit was originally developed to meet the requirements for a light-weight recorder to register the anomalies detected while prospecting for ore with airborne electromagnetic, magnetic, and radiometric equipment.

Bedfordshire, England

Pneumatic valves with operating speeds up to 300 cycles per minute are products of T.A.L. Numatics Ltd. Used to increase the speed of operation of equipment such as spotwelders, presses, transfer machines, and vacuum lifters, the valves employ no conventional seals. Instead, leakproof operation (at pressures to 250 psi) is assured by precision grinding of sliding spools to match the internal diameters of port cylinders. In the manufacturing process,



Electrostatic charging of paint particles keeps overspray to a minimum, gives a more uniform coating.

at Lu Van, Inc., furniture manufacturers, Belding, Mich.

Binks modular electrostatic spraying ups finishing production 40%

"Our finishing production increased 40% since installing a Binks electrostatic spraying machine," reports Mr. A. G. Van Syoc, Jr., president of Lu Van, Inc., fast growing manufacturers of contemporary furniture.

"Records also show," states Mr. Van Syoc, "a 15% cut in finishing costs and a 10% savings in paint. We feel that in every regard our Binks machine has vastly improved efficiency, product quality and operational flexibility."

Installation costs cut

Use of the existing Binks spray booth kept installation costs at a minimum. Designed for Binks integrated spraying systems the water-wash booth, formerly used for manual spraying, was incorporated in the automatic set-up without costly modification.

Lower cost, quality finishing

Thousands of manufacturers, like Lu Van, have increased both quantity and quality of spray finishing production with the help of Binks' engineers and equipment. They can help you, too. Whether your need is for a single unit or a completely integrated, highly automated system, Binks has the knowledge and exact machines to speed up your operation and produce superior finishes.

Free finishing analysis

Binks will show you the application method best suited to your needs. An analysis is made under production conditions with your products and your finishing and coating materials. You're not obligated in any way. Just call your Binks branch office or write direct to the address below.

Ask about our spray painting school
Open to all...NO TUITION...covers all phases

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EVERYTHING FOR
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each cylinder is gaged electronically. Gage measurements are then transferred to the grinder, and a spool is automatically ground to have a clearance of less than 0.0002 inch with that cylinder. The cylinder is assembled to an aluminum housing containing integral air passages, and a suitable base and spool actuating means are added. Valves may be actuated by solenoids, mechanical linkages, or air pilot devices.

Paris, France

Joint-venture corporation, headquartered in Paris, has been formed for the purpose of manufacturing and selling Thompson Ramo Wooldridge Inc. RW-300 digital control computers in the European Common Market. Overseas principals in the new organization, called Compagnie Europeene d'Automatisme Electronique, are Compagnie Generale de Telegraphie Sans Fil (CSF) and Intertechnique of France. The company, a part of TRW's International Div., will also provide applications engineering for the computer and associated equipment such as analog-to-digital converters and data loggers.

London, England

Thread-whirling machine developed by B.P.S. Machinery & Spares Co. Ltd., London, has been equipped with electronic correction controls that compensate for errors in the leadscrew or as a result of stretching of the material being cut. In operation, a workpiece is supported in a precision lathe and rotated by the headstock spindle. At the same time, a thread-whirling attachment on the lathe saddle is advanced by a leadscrew. The whirling attachment includes a motor-driven ring containing a number of single-point cutters that rotate around the workpiece to take a succession of small cuts.

When a pass is completed, the tools retract and the head returns to the starting position automatically. The electronic controls measure the errors in a test piece cut on the machine and feed the necessary corrections to the lead screw so that subsequent pieces will be machined accurately. Parts such as plastic extrusion screws, lead screws, and worms in diameters up to 4 inches can be produced on the machine.

FOSMATIC N/C TURRET DRILL

The drill that carries its own "tool crib". Machine hundreds of different parts without changing tools. Full 3-dimensional tape control including rapid tool selection with the 32-spindle turret. Combined General Electric Mark II and Fosmatic numerical control makes this unique, heavy-duty machine an efficient producer for drilling-tapping-milling with lot sizes as small as one!

NUMERICAL CONTROL *for more effective, lower cost*

DRILLING • TAPPING • MILLING

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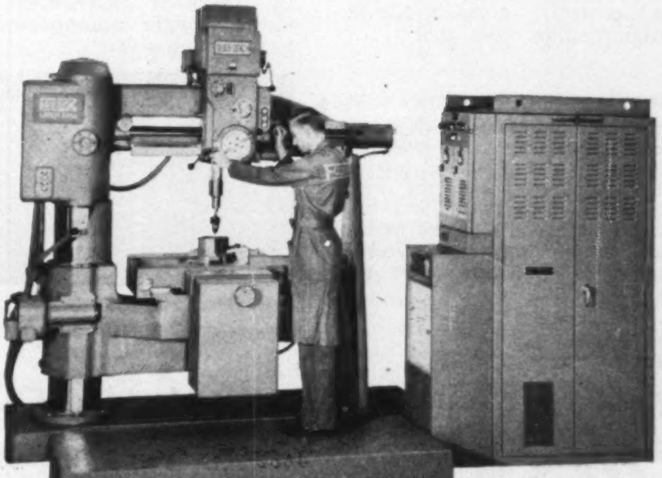
FOSDICK

THE FOSDICK MACHINE TOOL CO., CINCINNATI 23, OHIO

FOSDICK N/C LAYOUT DRILL

Keep costs low with this economical machine built to speed drilling and tapping jobs through your shop. Great versatility. Simple in concept, easy to operate. Proven, fast General Electric Mark II numerical positioning control, with full zero offset. The best buy in numerically controlled drills.



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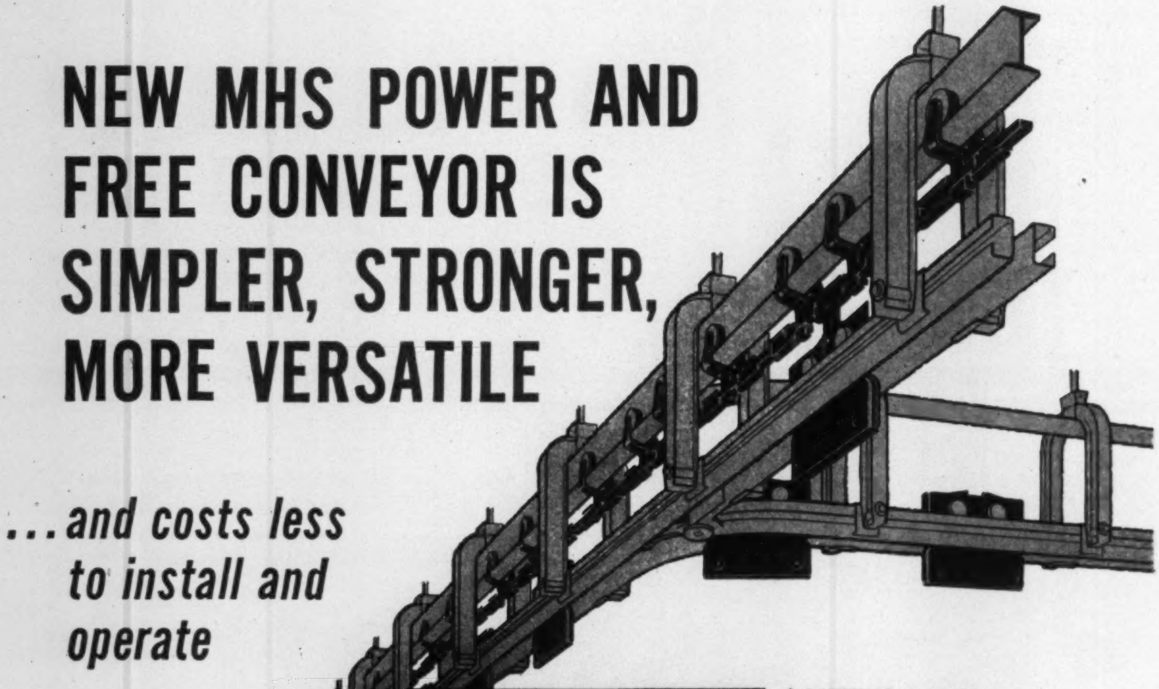
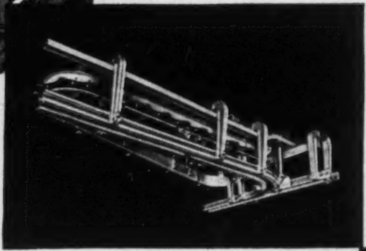
NEW MHS POWER AND FREE CONVEYOR IS SIMPLER, STRONGER, MORE VERSATILE

...and costs less to install and operate



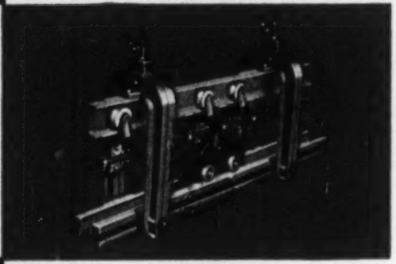
The new MHS Power and Free is redesigned throughout. Its low cost, simplified construction and more efficient operation make it economically practical in hundreds of plants where this conveyor type formerly was impractical.

New MHS Power and Free Conveyor is lower in first cost, lower in erection costs, and lower in maintenance costs, too.

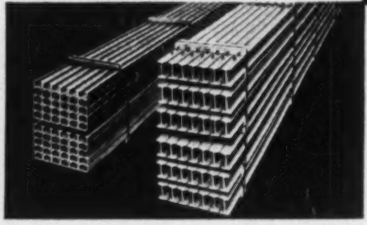


SWITCHES slave driven
Switches, shipped as units, are slave driven and cannot get out of synchronization. For reduced maintenance, switches, feeders, safety devices, interlocks and similar controls are mechanical, rather than electrical or air operated.

LIGHTWEIGHT strength
Weight is at a minimum, without sacrifice of strength. Load carrying trolleys run on two roll-formed C-sections, back to back. Yokes are formed steel, and are bolted to I-beam by means of pre-positioned studs. Longer unsupported spans are possible.



UNITIZED for simple assembly
New MHS Power and Free is almost a shelf item! Here are standard shipping bundles of I-beam and free track sections—enough for more than 600 feet of Power and Free Lines. Bolted splice plates replace much field welding, make erection easy. Parts are standardized and interchangeable.



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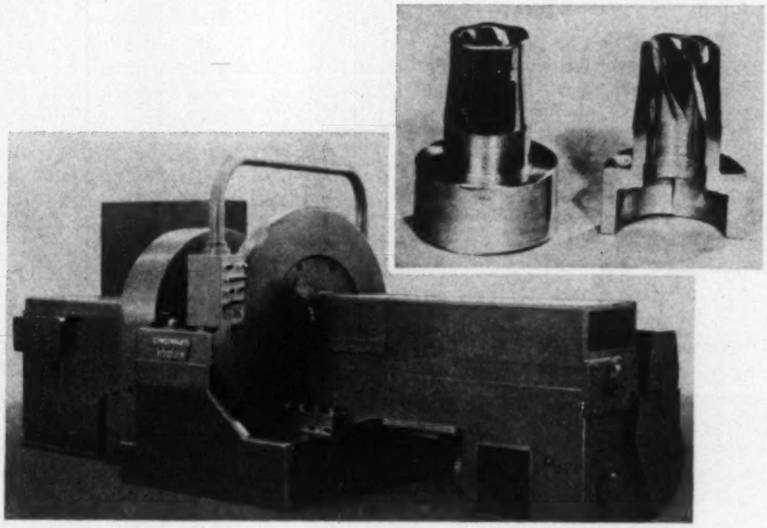
Circle 679 on Page 35

detroit dateline

By JAMES C. KEEBLER, Editor



Intraform machine made by Cincinnati Milling Machine Co. produces internal contours on starter clutch housings at Chrysler Indianapolis plant. Cutaway section shows straight cam surface in large bore and helical involute spline in small bore of workpiece.

Annual Report

RAPID TECHNOLOGICAL change and the increased automation of processes used by American business seems destined to do away with the annual report.

Instead of drawing a balance sheet once a year to see whether it has made money or gone broke, the corporate management has been decreasing the time between looks to the point where it will soon be looking at the situation full time. Various types of business analyses that formerly were made only on a yearly basis have passed through the semi-annual and quarterly stages and are now being required on a monthly basis. Integrated data processing techniques are destined to reduce the time of report preparation to a minimum. Some reports could be issued hourly.

In these critical times a manager must not only know how far in the hole he is, but in which direction he is moving, and how fast.

If this trend continues, editorial writers and business executives may lose their classic new year topic: "I am at heart an optimist." These words were used by Will Rogers to describe the annual barrage of speeches keynoting the fact that things look bright for the new year. Before the idea of doing so becomes completely obsolete, it might be well to take a look at the new year's outlook of automation and the auto industry.

Better Off Than . . .

Last year at this time our rosy glow meter showed a high reading. Everyone was interested in soaring into the 60's. In retrospect the boom seems to have been more imagined than real. In the American freely competitive society the citizen is motivated to strive hard to be well off. Often this motivation overshoots its mark and we get to thinking in terms of being better off than someone else. When a businessman gets carried away by competitive force, dominance of a market may appear to be the minimum essential, and sharing it with others can become unthinkable.

Whereas two years ago the auto industry was worried about the inroads of foreign competition on the American scene, last year reversed the trend, and next year should see the expansion of U. S. automakers in overseas markets. Ford's November move to own all of its British operation was heralded in financial circles as signifying a trend to invest Detroit's capital in rosier futures overseas. This could mean the end of a period of double talk from U. S. industrialists. Humanitarian exclamations pleading for statesmanlike assistance to underdeveloped nations were garbled by cross-talk from the other corner of the executive mouth protesting against the evils of foreign competition. Business statesmanship now sees the shoeless, televisionless, automobileless people of the world as potential customers instead of as barbarian Fords that might overrun us.

Certainly, it will take shrewd economic planning to assure us that we will stay well off at home while we are investing big in the economies of other countries who wish to be better off than they are.

Leadership Roles

Contributors to President Eisenhower's Commission on National Goals have seen leadership roles for Americans in science, technology, and economics in world affairs. The developments during 1961 in these areas of world activity will represent a big challenge to the Kennedy administration. Businessmen who are marking time now because no one knows what the new administration will do will soon be on the move again. Well wishers in autodom hope that R. S. McNamara's experience as a cabinet member will be a happier one than "Engine Charlie" Wilson's. Such high level industry representation in Washington should be not only good for the country but also good for industry. Time alone will tell.

More Plants

Meanwhile back in the shops, facilities expansion and improvement continue to take place. Chevrolet Division's Ed Cole announced that construction would start on a new assembly plant in the San Francisco Bay area in 1961, with completion scheduled by the fall of 1962. "We are confident that the west coast demand for our products will continue to outpace that of the country as a whole," Cole said in announcing plans for the new plant. This will bring to ten the number of car-truck assembly plants that Chevrolet operates in various corners of the U.S.A.

New plants provide one of the easiest avenues to obtaining more highly automated production facilities. No manufacturer would want to build a new plant in 1961 without making a big effort to incorporate the latest developments in production processes.

More Automation

Ford announced installation of a new conveyor system at the Cleveland Stamping Plant. Walter Miller, plant manager, says that the system provides for swift flow of scrap from the plant's 23 major press lines. At the end of the conveyor system, baling machines compress scrap into 800 pound cubes which are carried to railroad cars at a rate sufficient to fill three miles of freight train per month.

Additional equipment installations to facilitate more automated operations will have a ready market in 1961 where economic justification analyses show that the savings in manufacturing costs provide an adequate return on capital investment.

New Processes

Methods improvements and new automated techniques for manufacturing old products can be expected to see further development in 1961. Manufacturing engineers are particularly interested in new processes that enable the manufacture of parts without having to also make piles of chips.

Once upon a time, chip making was the name of the game for the machine tool industry. Nowadays, however, many machine tool builders have come to see the merit in developing production processes that produce complex contours in workpieces without the laborious task of chip-by-chip metal removal. The world's largest machine tool builder, Cincinnati Milling Machine Co., offers techniques of Hydraforming, Hydrospinning, and Intraforming through its Meta-Dynamics Div. This later process has been applied in automated fashion at Chrysler's Indianapolis plant.

Stepped cylindrical blanks for starter motor clutch housings are magazine fed to a loader mandrel that inserts them one at a time into the spindle of this cold forming machine. As the workpiece rotates at 220 rpm, cam-actuated dies are moved by hardened steel rollers in a raceway in the headstock. Quantity and arrangement of rollers and dies are such that 1500 pulsating squeezes per minute are exerted on the outside of the workpiece blank thus forcing its interior shape to conform to that of the internal mandrel.

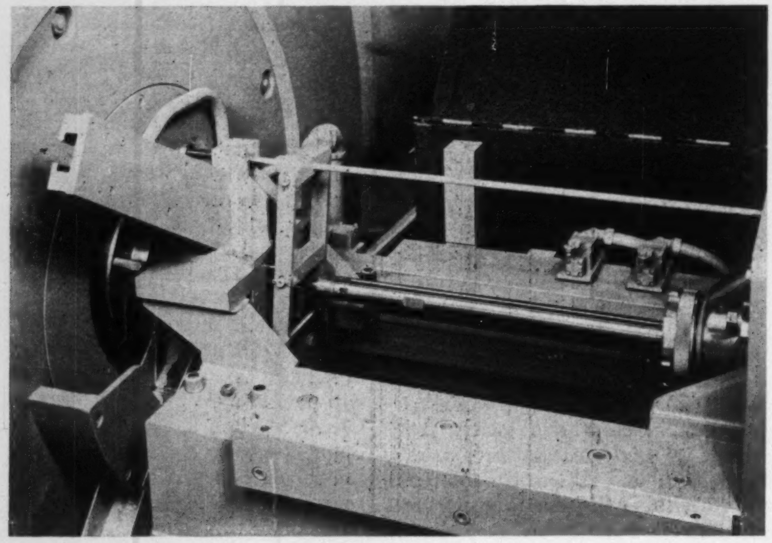
The 200 ton squeezing capacity of the machine cold forms the parts into very accurate conformity to the shape of the mandrel. This particular job involves four straight cam faces in the larger bore and a helical involute spline in the smaller bore of the starter clutch housing. By use of a two piece mandrel the straight and helical portions are nonconflicting so far as withdrawal of the mandrel is concerned, so that both of these internal contours can be formed simultaneously in one cycle of the machine.

As the mandrel is stripped from the workpiece, the internally formed housing is discharged into a chute, and the machine is ready for the next blank to be automatically loaded into the headstock spindle.

This equipment embodies the three phase approach to automation. Work is performed automatically. Handling of workpieces is accomplished automatically. An automatic control system interlocks the two. It provides two extra plus factors by simultaneously forming two surfaces that would otherwise require two separate operations to accomplish and an extremely accurate repetition of tolerances from part to part.

Promising Challenge

For the manufacturing engineers charged with the responsibility of meeting the production problems of 1961 such processes hold great promise. Automatic cycling machinery that simultaneously produces more than one contoured surface represents a considerable stride toward more automated manufacturing operations. As the industry expands to better serve the markets of the world, and new plants are built to make automobiles, and old operations are up-graded for more efficient production, automated production equipment of this nature will come into more widespread use.



Handling device for Intraform machine provides for automatic loading and unloading of the workstation. Blanks are fed from magazine into headstock and removed after work cycle is complete. Finished part is stripped from mandrel and drops into discharge chute.

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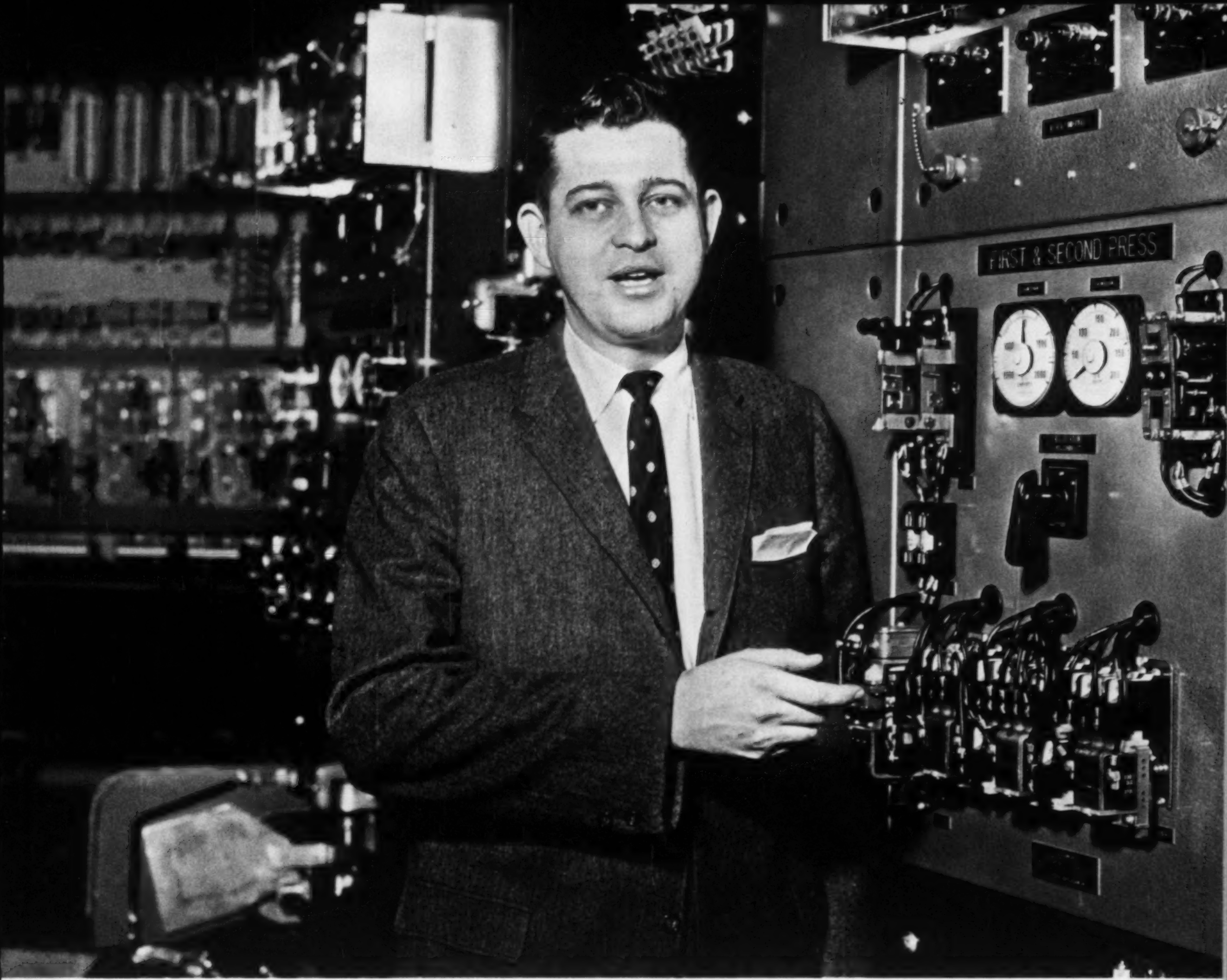

T. R. Corn, Sales Engineer, Akron District Office.

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Reliance meets the peculiar needs of progress.

Loading or unloading of United Jet Mainliner passengers in three minutes is now an accomplished fact at major air terminals.

Product of the jet age, this "Jetway" passenger loader came to life as a result of some unique engineering on the part of Reliance and the Pacific Iron and Steel Co.

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Adapting Reliance products to this unusual vehicle called for imagination and ingenuity . . . and the "Jetway" works fine.

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EMSCO
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Something more than electricity keeps this Reliance Motor running.

The oil field motor that drives this unit is protected, inside and out. It is not affected by dust, dirt, water or changes in the weather.

Reliance engineered and built this weather-proof motor, which is operating an oil well pump, in order to provide continuous operation with negligible maintenance . . . otherwise it wouldn't be where it is.

There are many such areas in the country where Duty Master Motors are subject to extreme environmental conditions. Yet the weather-proof is only one of a broad line developed to meet any a-c. motor requirement . . . and that takes in a lot of territory. Duty Master's wide acceptance is testimony to the creative engineering which produced it.

This 15 hp. Duty Master operates an oil well pumping unit at the Fair-Glenn Field, Sapulpa, Oklahoma. Sound insulation, rodent screens and the "Metermatic" lubrication system are vital qualities of this motor which performs so well in areas where weather and infrequent supervision are factors. It runs 24 hours a day regardless of adverse conditions.

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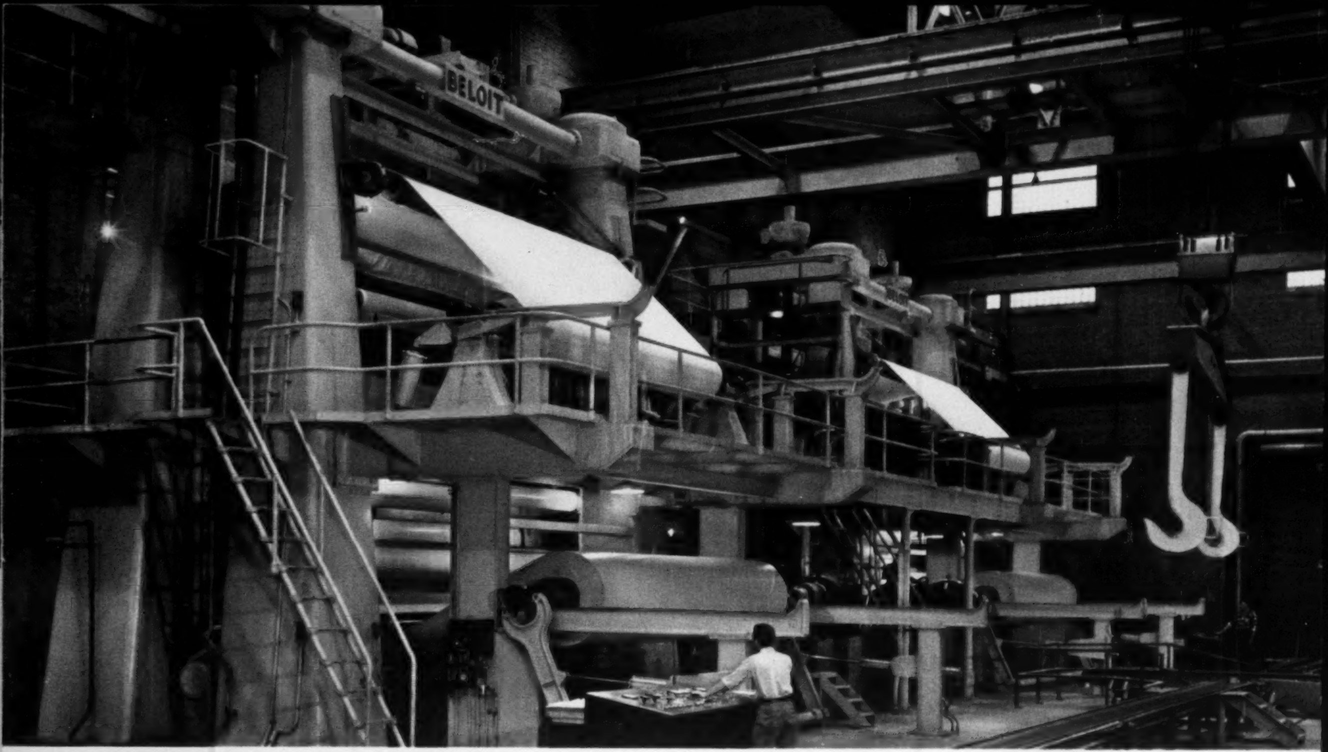

It takes more than horsepower to make a quality product.

These two super-calendar machines put a rich, glossy finish on paper. Alternate steel and cotton rolls produce a buffing, or polishing action on the previously treated product. Reliance Drives keep speeds of various rolls exactly regulated so that uniform, precise tension is maintained.

The big design trick here is to maintain exact tension during acceleration and deceleration of the drive system. Process requirements call for frequent speed changes. Any variation of tension during these changes is dangerous. The paper "web" can break, rolls can jam, the system can go haywire. But this one doesn't.

Reliance Engineers were in on this installation from start to finish . . . worked with company engineers to assure sound operation.

Tachometer feed-back systems with Reliance regulators keep the system perfectly controlled. Motors are synchronized to keep paper flowing smoothly at 2,000 feet per minute. A total of six machines in this mill are powered and controlled by Reliance, testimony to creative engineering and intelligent application.

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AUTOMATION

Manufacturing Idea

On the wall of Roger Bolz's office is a quotation from Victor Hugo, "Greater than the tread of mighty armies is an idea whose time has come." The idea that industrialists need and recognize the value of an engineering approach to the problems of manufacturing, and that automatic manufacturing operations are the avant-garde of this movement is powerful indeed.

In the six and one-half years since Vol. 1, No. 1 of this magazine was published, this idea has certainly come into its time. Corporations have created manufacturing engineering departments. Union contract productivity clauses have established a minimum pace for guaranteed annual automation. Government groups have recognized the need to study and plan the advance. Technical magazines and an engineering society have added the word "manufacturing" to their old names. A new Manufacturing Engineering Council has been formed. In short, everybody's doing it.

The concept of selective-media technical publishing laid down by Penton's board chairman, George Hays, describes the role of the editorial staff as that of adult educators. In keeping with this ideal, AUTOMATION provides a balanced curriculum of educational material for those interested in learning more about automatic manufacturing operations. In an age when corporations in all industries are moving in this direction, this presents a broad challenge to professional people in this field: Follow the needs and developments of manufacturers and lead their thinking toward solutions.

In the course of presenting the previous 77 editorials that have appeared in this position, Roger Bolz has keynoted the thinking behind the technology of automation. In following him at this assignment, we aspire to make as great a contribution to this idea whose time has come.

Industry needs more engineered manufacturing operations. Automation is essential to making them more productive. Industrial productivity is a powerful force behind national growth. The time has come for men who devise and manage manufacturing operations to learn more about these ideas.

James C. Keebler

EDITOR

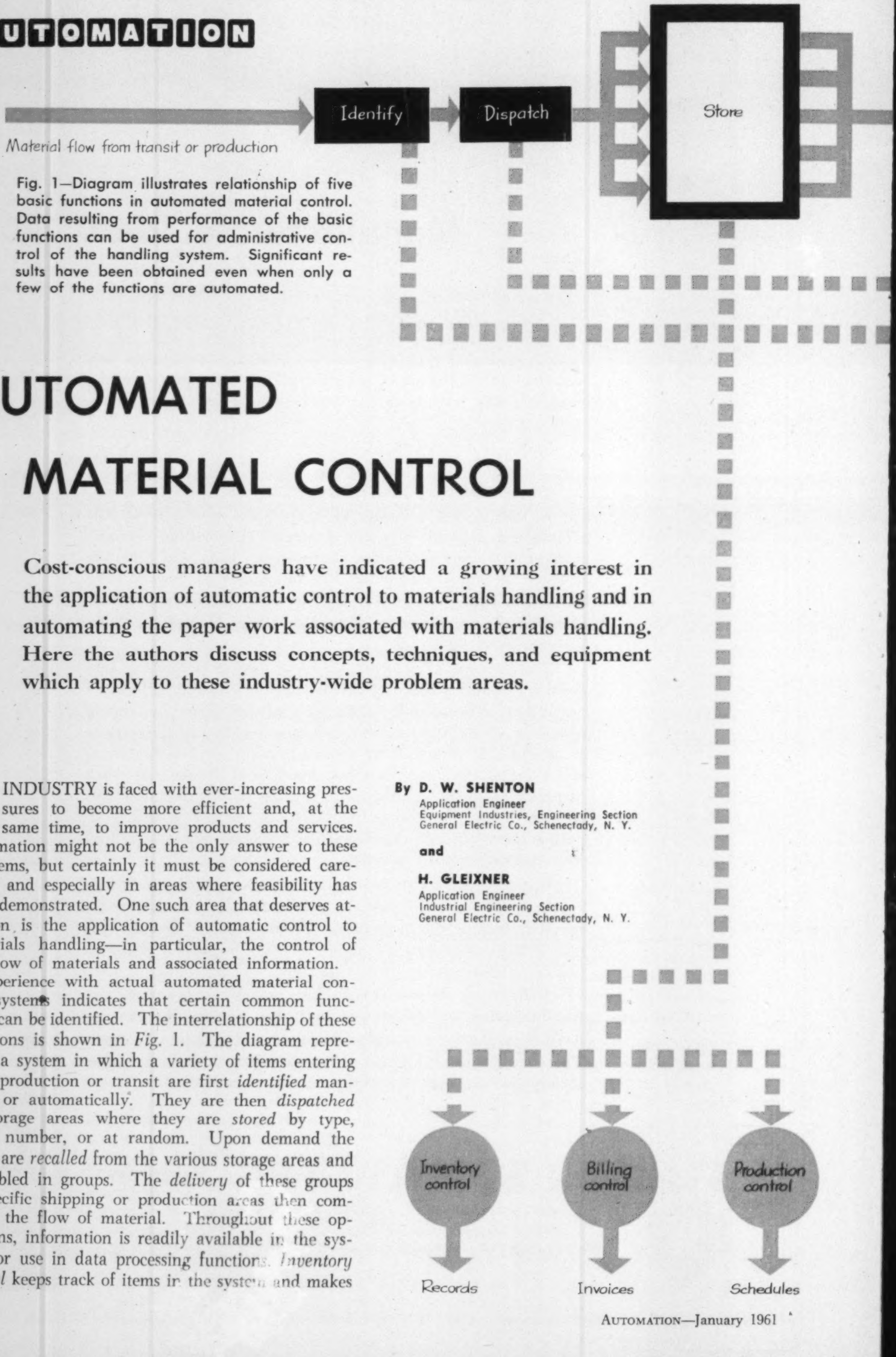

Fig. 1—Diagram illustrates relationship of five basic functions in automated material control. Data resulting from performance of the basic functions can be used for administrative control of the handling system. Significant results have been obtained even when only a few of the functions are automated.

AUTOMATED MATERIAL CONTROL

Cost-conscious managers have indicated a growing interest in the application of automatic control to materials handling and in automating the paper work associated with materials handling. Here the authors discuss concepts, techniques, and equipment which apply to these industry-wide problem areas.

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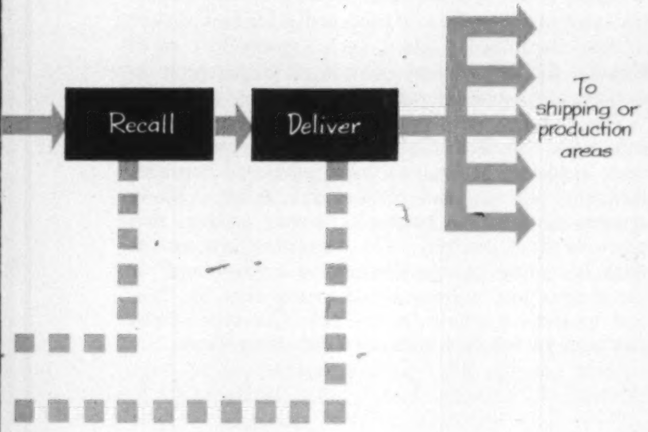
INDUSTRY is faced with ever-increasing pressures to become more efficient and, at the same time, to improve products and services. Automation might not be the only answer to these problems, but certainly it must be considered carefully, and especially in areas where feasibility has been demonstrated. One such area that deserves attention is the application of automatic control to materials handling—in particular, the control of the flow of materials and associated information.

Experience with actual automated material control systems indicates that certain common functions can be identified. The interrelationship of these functions is shown in *Fig.* 1. The diagram represents a system in which a variety of items entering from production or transit are first *identified* manually or automatically. They are then *dispatched* to storage areas where they are *stored* by type, serial number, or at random. Upon demand the items are *recalled* from the various storage areas and assembled in groups. The *delivery* of these groups to specific shipping or production areas then completes the flow of material. Throughout these operations, information is readily available in the system for use in data processing functions. *Inventory control* keeps track of items in the system and makes



this information readily available. *Production control* uses the data available on orders or inventory to help schedule production. *Billing control* uses the orders-shipped information to produce records, invoices, shipping labels, packing lists, etc.

The basic control functions (*identify, dispatch, store, recall,* and *deliver*) regulate the flow of material through the system. *Inventory control, production control* and *billing control* are primarily concerned with the flow of information or data through the system.

The over-all concept of automated materials control is the integration of these eight basic functions into a single co-ordinated system. Most of the applications to date involve only three or four of these functions. For example, one manufacturer automatically recalls cases of stock from manually loaded storage areas to fill orders. This is the familiar order picking function. Another manufacturer automatically identifies, dispatches, stores, and uses inventory control for small mechanical assemblies.

▶ Identification

The first control function, *identify*, can be accomplished either manually or automatically. Manual identification involves an operator who visually recognizes different types, colors, sizes, addresses, or whatever identity is necessary and who either puts this information into a control memory system with pushbuttons or physically "tags" the item or a carrier. The input to the control memory usually is in the form of keyboards, dials, or pushbuttons. Tags take the form of codes for readers using photoelectric, magnetic, or contact making principles. In *Fig.* 2 an operator at General Electric Co.'s Appliance Park is shown identifying different types of appliances and putting the information into a control memory with pushbuttons located on his control console. As the conveyor "train" enters the selection zone, a photoelectric limit switch that indicates the train is in the selection zone lights a *Select* light on the operator's console. The operator then presses the proper exit pushbutton. For example, this action could identify the train as "washing machines destined for storage exit number 6."

Identification of trays of mail at the Boston Post Office is accomplished with coded tags in the form of special punched cards. For example, an operator who has collected a tray of mail destined for St. Louis would place a coded card on the side of the tray that identifies it as "St. Louis mail," thus performing a manual identification function. The card is made of a conductor covered with insulation. "Holes" in the insulation provide the code for a particular desination. The second method of identification, automatic identification, does not require an operator but identifies items by recognizing significant physical characteristics of the object, such as size, weight, or chemical composition. The input to the control memory in this case may originate with limit switches, load cells, or composition detectors such as x-ray devices.

A stator punching sorting system, *Fig.* 3, illustrates automatic identification. The punchings are weighed automatically and directed to one of 15 storage bins depending upon their weight category. Difference in weight for punchings comes from variations in the iron, and sorting the punchings by weight categories enables better control of the amount of iron stacked into a stator. As another example, the lumber industry makes use of limit switches to sort mixed lengths of lumber on a conveyor. This is done simply by arranging the limit switches (mechanical or photoelectric) to determine the length of a board by counting the number of switches that the board actuates simultaneously. The same principles could be applied to identify different size packages.

▶ Dispatching

The second control function, *dispatch*, can be accomplished in one of two basic ways. It is possible

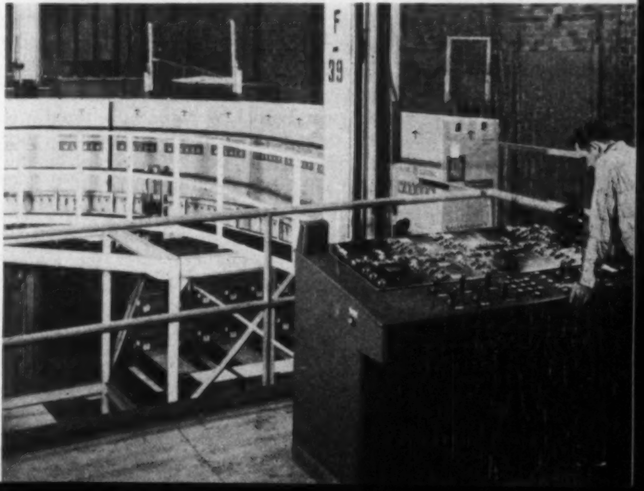
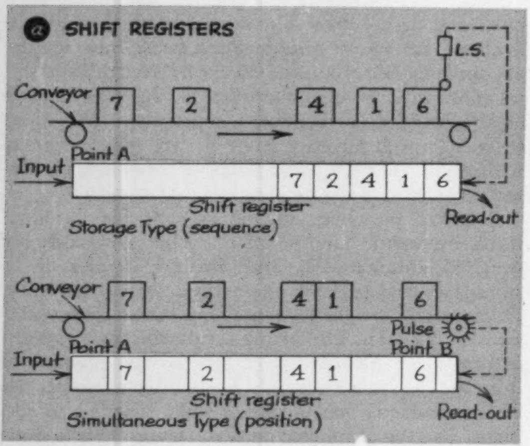


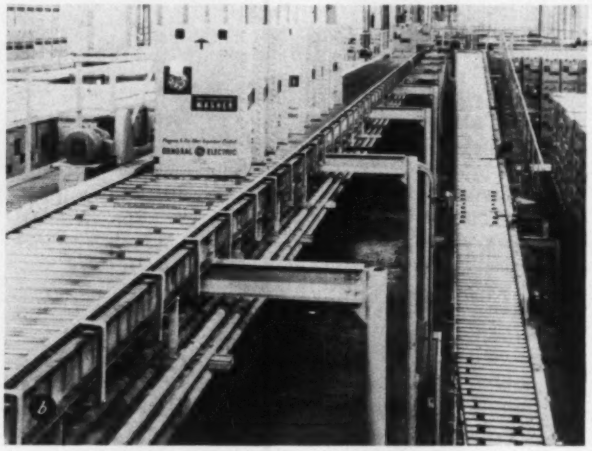
Fig. 2—At console, operator introduces data into control system based upon his observation of what items are in the cartons. At some other point in system, data will be used to actuate diverter gates leading to other conveyors.

to either read the identity of the item at each conveyor exit, or identify the item at one point and remember the identity and location of the item as it passes through the conveyor exit areas, *Fig.* 4. When the exit code and the item code match, the object is discharged.

Read identification dispatching involves reading the identification of each item at each storage exit and either diverting it or letting it pass by. The item's identity may have been previously established manually or automatically. For instance, the item may have been identified previously by weight and have had a code stamped on it that can be read photoelectrically. At each storage exit a photoelectric decoder would read the code and control the diverting gate. On the other hand, the item's identity may not have been established prior to the time it was dispatched. Then each storage exit must identify the object and control its dispatching to storage, all in one operation.

The decoders may work on any number of basic principles. Some of the more popular types include those made up of limit switches, electrical contacts, magnetic pickups, and photoelectric relays. Many systems in operation consist of fingers or dogs that protrude from carriers. The dispatcher sets up the dogs according to the destination desired and, at the destination, a limit switch senses that the dogs are up and the carrier is diverted. This type of dispatching system has been used for many years.





MEMORY TECHNIQUES

A SHIFT REGISTER is a group of relays, stepping switches, or static logic elements so arranged as to provide for the sequential transfer of information placed in one device, section, bank, or group of devices to the next device, section, or group of devices. In the sense that information is placed in such equipment at one moment in time and removed at a later moment, shift registers can be said to provide "memory." For material control applications there are two basic types of shift registers, one to remember the sequence of items (storage type) and one to remember the position of items (simultaneous type).

Both types of shift registers have the ability to receive information, store the information, and present it in the order received. However, different means must be used to tell them when to present the information, *Fig.* A.

A storage shift register is told to present the identity of an item when the item actuates a sensing element, such as a limit switch. This type of memory is needed for dispatching items that will not necessarily maintain a fixed relationship on a conveyor because of gravity sections, slippage, or because the items vary in size and shape. A simultaneous type shift register is told to present the identity of the item after a specified number of pulses (generated by conveyor movement) have been received. Each pulse moves all information items forward one interval which may correspond to one division on the conveyor.

What is done at the read-out point with the information depends upon what is to be accomplished. In a simultaneous type shift register application the code for a given item may be compared with the code for the desired item to be exited. If the codes are alike an ejector is actuated to divert the item. If they are not alike, the code is carried on to the next section where additional comparisons and diversions may be made. In a like manner item identification and diversion are accomplished with a storage type shift register.

It is very important that a fixed relationship be maintained between items when a simultaneous shift register is used. After a given item is placed on the conveyor, the system must provide that a certain number of pulses later the item will be exactly in front of the gate. A storage shift register on the other hand will never believe an item is in front of a gate until the item actuates a limit switch located at the gate.

A storage type shift register is used to remember the sequence of "trains" of appliances at GE Appliance Park, *Fig.* B. A train of appliances is shown proceeding along the main conveyor. On the right is a spur leading to one of eight storage areas. Typically, when the train reaches an exit to a spur a photoelectric beam is broken and the code assigned to that train is compared with the code acceptable at that exit. If the code is correct for that exit, the train is diverted. If it is not correct, the train passes the exit and its code is placed in the next section of the storage shift register, where it is compared at the next exit.

The U. S. Post Office "Mail Flow" system at Boston, mentioned earlier, is a good example of the type of dispatching using coded carriers which are read at each possible exit point. The trays which carry the coded cards are used over and over. Four fingers protruding from the decoder at each exit can be set for the acceptable code. When the fingers run over a passing card, if electrical contact is made through all four fingers because of the "holes" in the insulation, the code is correct and the tray is diverted at that exit.

An alternate method of identification for dispatching, or other purposes, is to place the code to be read on the object itself. For example, a photoelectric decoder has been developed specifically for this type of dispatching, *Fig.* 5. This decoder consists of light sources, a lens, and a group of photoelectric relays. The code may be made up of any number of squares as shown. The three lower marks are always the same. They constitute the trigger code that tells the decoder the object is in position to be read. The dark and light squares provide a binary code that identifies the desired exit point. Photoelectric codes can be preprinted on each carton to be identified.

The other method of dispatching, *remember identification dispatching*, where the identity of the item is remembered, requires that some form of memory be provided in the control panel. The techniques and hardware used to accomplish the memory function vary widely but all of them operate on one of two principles. Either they remember the sequence of items without regard to item spacing, or they remember the position of each item.

The memory device for remembering sequence will generally be a storage type shift register. The mem-

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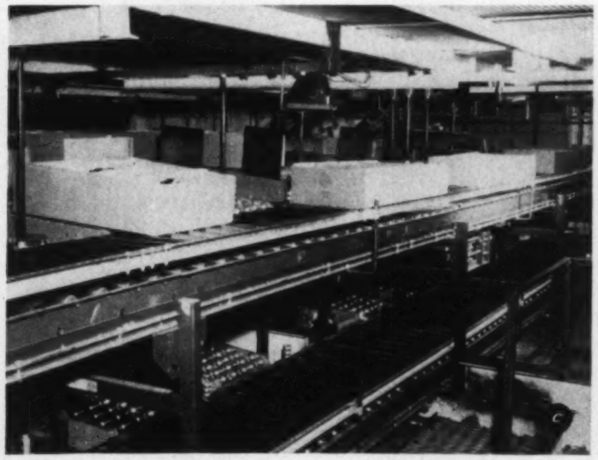
Shift registers can be made up from many different components such as relays, static switching units, magnetic cores or drums. Unless there are very few items to remember or a great many, static switching units prove most economical for shift registers and, in addition, offer extreme reliability, compactness, and ease of maintenance. As an indication of the reliability which can be obtained, the appliance conveyor system shown in the illustration has been in operation over 3 years and has had almost no downtime from static switching component failures.

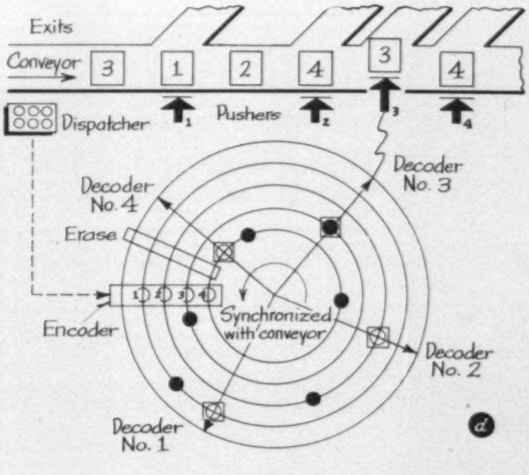
A simultaneous type shift register is being used at A-C Spark Plug Div., General Motors Corp., to remember the position of items being dispatched to storage lines, *Fig.* C. Cartons filled with different dashboard assemblies for Buick, Pontiac, and Chevrolet cars, etc., are first identified by a dispatcher as they come from the plant assembly area. They are then dispatched to nine separate storage lines on a live roller conveyor. The simultaneous shift register receives a pulse each time the items move forward one interval. The code in the memory unit corresponding to a position opposite each exit is compared with the code desired at that exit. When the codes match, a gate is actuated to divert the cartons. In this installation static switching units are used also to make up the shift register.

Other control techniques may be used for dispatching where the position of the item on the conveyor can be remembered. On very complex systems where a very large number of items must be remembered, a magnetic drum of the type used in computers may be used. For extremely simple systems a disk type memory using a simple encoder and several decoders may be used.

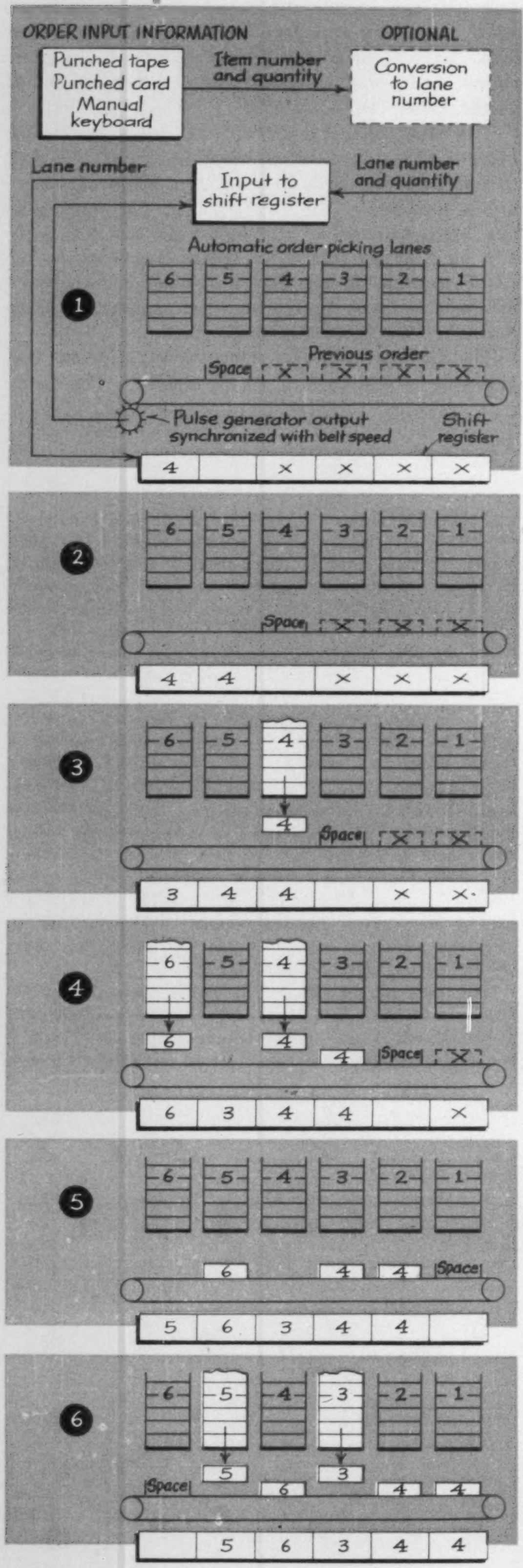
The disc, *Fig.* D, has four tracks on it and is synchronized with a conveyor. One revolution corresponds to the length of the conveyor from the dispatcher to a point past the last exit. As the dispatcher identifies an item with a pushbutton (or this could be an automatic identification) a code is placed on a particular track. For example, as shown in the diagram, Item 3, which has just passed the dispatcher, is represented by a code on Track 3. When the code on the disc reaches Decoder 3 the box arrives opposite Exit 3. The ejector is actuated and the item diverted. The sketch also shows Item 1 and its code approaching Exit 1 and Decoder 1. Item 2 is halfway between Exits 1 and 2 and likewise the code is halfway between Decoders 1 and 2. After the codes pass Decoder 4 they are erased, thus clearing the disc to receive new information.

More exits can be handled by adding more discs or by arranging the code in a binary fashion. For example, with a binary code Exit 5 would require a code on Tracks 1 and 4; and Exit 6 would require a code on Tracks 2 and 4.





FULL CONVEYOR SYSTEM



THE DIAGRAM illustrates the General Electric Co.'s Full Conveyor automatic order picking system. An order to be filled by two items from Lane 4, and one each of items from Lanes 3, 6, and 5 is entered into the shift register (note that the lane numbers can be entered into the shift register in any sequence). At Time 1, Code 4 enters the first bank of the shift register. Code 4 does not compare with Lane 6, so no item is released. On the next shift pulse (Time 2) Code 4 is shifted one bank and the second Code 4 enters; neither of these numbers compares with the lane they are opposite, and again no items are released. On the next shift pulse (Time 3), both Code 4s are shifted one bank and Code 3 enters the register. Now, the first Code 4 compares with Lane 4, and an item is dropped on the belt. At Time 4, Codes 6 and 4 in the shift register are opposite Lanes 6 and 4, and one item is dropped from each of these lanes. The space between them on the belt will be filled later. On the next shift (Time 5) no comparisons are sensed but at Time 6, Codes 3 and 5 in the shift register compare with Lanes 3 and 5, and one item from each of these lanes drops onto the belt completing the order.

The next order can start immediately after the last space reserved for the preceding order. A fixed number of spaces

ory for remembering position can be a simultaneous shift register or a device, synchronized with the conveyor, that can be "marked," such as mechanical pinwheels or disks; magnetic drums, disks, or tapes; or paper punch tapes. The box entitled, "Memory Techniques," discusses the memory function in detail.

▶ Store

The third basic control function, *store,* represents a buffer between flow rates into and out of the system. Items are generally stored in one of two ways: By classification, or at random. For example, a luggage manufacturer may want to store luggage by types and colors, but an airline passenger baggage handling system must use a random storage from which specific luggage can be recalled for delivery to individuals. An auto manufacturer would desire to store by type, color, and style but a parking garage must have a random serial storage to be able to recall a particular auto.

Activity within the storage area is limited to accepting dispatched items, giving up recalled items, counting in and out for inventory data, and moving items within the storage lines to facilitate random access where needed.

The installation at the AC Spark Plug Div., General Motors Corp., mentioned in the box entitled "Memory Techniques," also keeps track of the cartons in each storage line. As cartons are dispatched into the various storage lines, they are counted in. Thirty cartons, for example, could be considered a full line and no more would be allowed in until the line has been emptied. A storage shift register controls the sequence in which the lines are emptied. The company desired a first-in first-out inventory control scheme in which the first line to fill up will be emptied first, the second line, etc. Since several or a tote box can be automatically inserted between orders. Feedback from gates assures that a carton is counted out, and absence of feedback causes a "short" to be indicated or printed out for that lane and order. Jams interrupt the shift pulse, shut down the take-away conveyor, and prevent further dropping of cartons until the jam is cleared.

The system capacity is limited by the delivery rate of the slowest lane. For example, if the slowest lane can operate at one carton a second, the system can be geared for 1 pulse per second, and will pick 60 cartons per minute.

Many alternates to the basic scheme as described here are available. For instance, to save floor space the racks may be two, three, or four levels high. Only one shift register is required for these multilevel operations if the resulting capacity is sufficient. The reserved space on the conveyors is not limited to the width of one lane, but rather it can be made any multiple of lane width. The knowledge of where the beginning of each order is can be used to deliver that order to the proper truck dock.

The basic control design uses static switching techniques from the output of the card reader, tape, or keyboard to hermetically sealed output relays. Solid-state devices keep maintenance at a minimum and provide high reliability.

of the lines may fill up at about the same time, the storage shift register is used to remember the sequence and control the gates to empty the lines in that sequence.

▶ Recall

The fourth basic control function, *recall,* is concerned with retrieving from storage items previously placed there. The recall function is not quite the inverse of the dispatch function because the identification of the item is already known simply by its storage location. The most frequent use of the recall function is in order picking. Orders may be filled in one of three ways:

1. One item at a time. This simply involves opening a gate and counting out of the correct storage line the quantity of the item desired.
2. One order at a time. This involves counting out the desired quantity of items from each of several different storage lines, sequentially or simultaneously, and collecting the order on one conveyor.
3. Several orders at a time. This requires a much more complicated recall system since the control must now remember to which order each of the recalled items belongs so it can be delivered to the particular shipping dock collecting the order.

While recall may be accomplished manually by selecting items by pushbuttons, it will frequently require more sophisticated direction such as punched tape or card inputs for order picking.

There are three basic control techniques used for order picking systems today. First is the sequential type system which has been used in some form on all of the installations operating today; second, and most important for future jobs, is the newly developed General Electric "Full Conveyor" system; and third, and worthy of mention for some applications, is a simultaneous drop approach.

Sequential order picking systems control the automatic picking racks in such a manner that Lane 1 is always picked before Lane 2, Lane 2 before Lane 3, etc. By picking in sequence, collisions of cases are avoided on the conveyor. Decks of automatic order picking racks can be picked in series or simultaneously depending upon the system capacity desired.

The information input to this system—whether keyboard, tape, or cards—must either be presorted in sequence by lane number or sorted in the control. To accept unsorted information, the control must have a memory that has the capacity to store quantity information for each automatic order picking lane in the system. Presorted information enables the control to keep the automatic racks picking by using only a "partial" or "buffer" memory. This partial or buffer memory then must store lane and quantity numbers. The amount of storage is determined by the difference between the rate of input of information and the rate of picking.

In one warehouse installation, an automated recall system picks orders from 72 storage racks. The operator's control console for the automated order picking system is shown in *Fig. 6.* The system is designed to accept an order in the form of a stack of punched business machine cards. The cartons

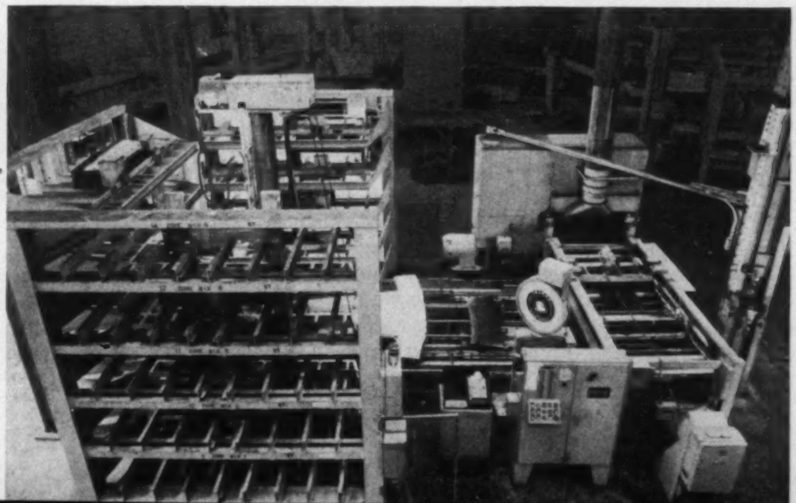


Fig. 3—Control data can be sensed automatically as in this installation where large stator punchings are being classified by weight. Depending upon sensed weight, items are directed automatically into one of 15 bins. As shown in photograph, flow of material is from right to storage bins arranged in U-shape about a central handling mechanism, left.

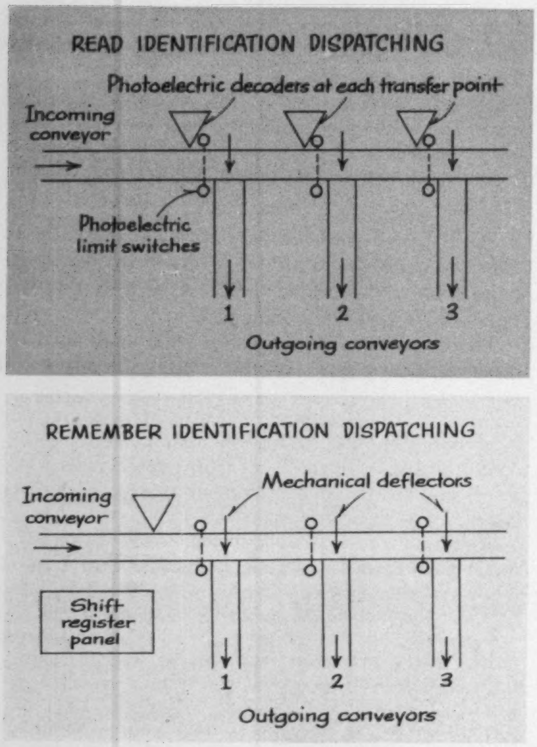

READ IDENTIFICATION DISPATCHING
Photoelectric decoders at each transfer point
Incoming conveyor
Photoelectric limit switches
1
2
3
Outgoing conveyors
REMEMBER IDENTIFICATION DISPATCHING
Mechanical deflectors
Incoming conveyor
Shift register panel
1
2
3
Outgoing conveyors

Fig. 4—Examples of the basic means of dispatching items are illustrated in diagram. With both techniques, an item on the incoming conveyor will be diverted to a particular outgoing conveyor. In "read identification dispatching" each exit point has capability of identifying items and controlling diverter gates. In "remember identification dispatching", the identity of item is sensed ahead of all exit points. A memory device relates identity to a particular exit point.

are stored in three decks of gravity fed racks. Each deck has 24 lanes for a total of 72 storage areas. The cards are fed into the card reader at the operator's control console where order information coded on the cards is converted to storage rack number and quantity. After the complete order has been read and stored in the system's memory, the memory circuits for the various storage racks are scanned. When the memory indicates a certain quantity is desired from a particular rack a gate is actuated and the proper number of items is counted out. Powered conveyors carry the items away from the racks and to the order assembly area. After all 72 storage racks have been scanned and the orders picked, the next order is read into the card reader.

Full conveyor order picking systems pick orders by reserving space on the take-away belts for each carton before it is picked. As the order is read into the control, a shift register accepts lane numbers for desired picks. If two cartons are desired from Lane 4, then the number 4 is written into two adjacent shift register banks. Each time the take-away belt moves the equivalent of a lane width, a pulse generator shifts all information one bank in the shift register. The numbers in the banks are compared with the lane numbers opposite each bank and when they are alike, an output relay energizes the corresponding gate on the automatic racks. The net result is that each space on the take-away belt is full. The basic technique of this form of order picking is illustrated in the box entitled "Full Conveyor System."

Simultaneous drop order picking systems can be used where collision between items need not be avoided on the take-away belt. Characteristics of these applications are large numbers of items, small orders, and small items (probably broken case lots). Here a partial memory technique is applicable, geared to drop items simultaneously from the lanes, without regard for lane sequence.

▶ Delivery

The fifth basic control function is *deliver*. Delivery of recalled items to specific production or

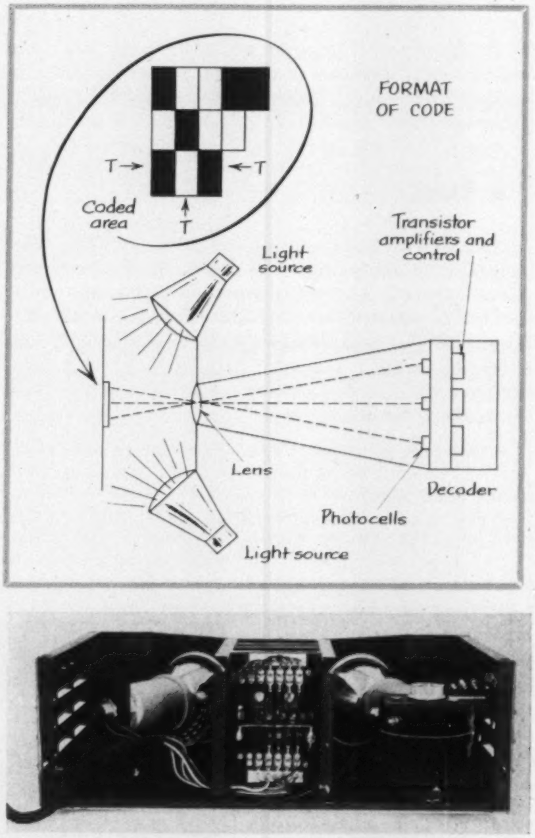

FORMAT OF CODE
T→
←T
T
Coded area
Light source
Transistor amplifiers and control
Lens
Decoder
Photocells
Light source

Fig. 5—Photoelectric system provides means of reading coded information which has been preprinted on package. Code is formed by the pattern of dark and light squares. The pattern of the three squares indicated by "T" is a reference code that, when sensed, indicates a package is in position to be read

shipping areas is similar to the dispatching function but it is a separate system problem and usually unlike the dispatch problem in the same system. Usually the identity of an item is remembered until it has been delivered to the proper area, once it has been recalled. Identification of an order which has been recalled and loaded on a pallet may be made by tagging the pallet and then reading item identity. In this case the pallet could also have been identified manually and its identity remembered as it was sent to the shipping area.

Once a system has been designed to accomplish the desired basic material handling control functions, information becomes readily available which may be used to advantage in other parts of the business. Frequently the use of data processing equipment will make possible significant improvement in operations and business procedures of portions of the business responsible for inventory, production, and billing. Thus, the three basic data processing functions of automated material control systems (*inventory control, production control,* and *billing control*) are concerned with the control and flow of information through useful channels.

▶ Inventory Control

Keeping track of inventory in a warehouse or production area by manual methods is time consuming and often unreliable, and it is difficult to continually have up-to-date figures available. Inventory control involves sensing, remembering, and displaying counts of items. It may include items in storage, in process, in transit, or all three. The display may be continual, such as a mechanical counter displaying a running count of the number of each type of item in storage, or it may be typed out or visually presented on demand or periodically in which case the information is stored in some type of memory prior to presentation.

The subfunctions of inventory control are data presenting, data accumulating, and calculating. Data presenting can be accomplished with mechanical counters, electrically pulsed, that can count up or down; numerical indicating lights; decade counting tubes; or typewriters. Data accumulating can be accomplished with mechanical counters, two way stepping switches, static counters, or magnetic drums or tape. Calculating (add, subtract, multiply, and divide) can be carried out with arithmetic units built to accomplish specific operations, or by a general purpose industrial type computer such as the GE 312, where it can be applied to the complete system.

When inventory control is to be used in a system incorporating any of the material handling control functions, some portion of the equipment to do this job may already be present. For example, a manufacturer automatically dispatching his products to a number of storage areas may need to count them in and out of the storage areas to prevent jam-ups. Adding inventory control then requires only the addition of appropriate display equipment.

The automatic order picking control console shown in *Fig.* 6 does not illustrate inventory control as such but does show display equipment backed up with counters similar to that which could be used for inventory control. As orders are filled simultaneously from three decks of product storage lanes or racks, the four numerical indicating lights for each deck show the number of the lane in that deck followed by the quantity being counted out. If a lane is out of stock the counter will stop counting down and give the operator an alarm. He may make a note of the amount the order is short (from his visual indicator) and then clear the machine so it can continue automatically. This also gives the operator an opportunity to notify the proper people to fill the lane with stock.

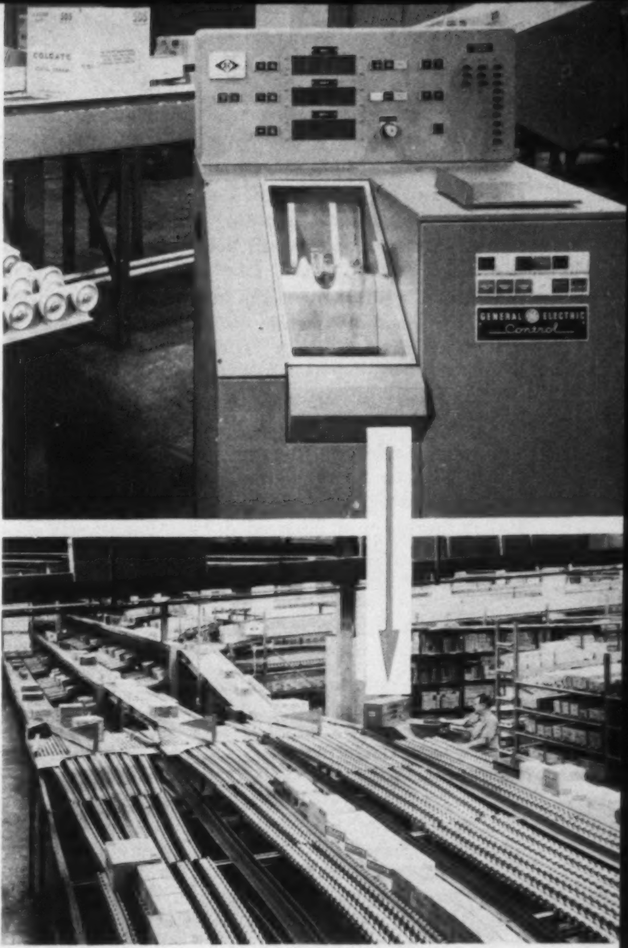


Fig. 6—Extensive automatic warehousing installation designed and built by Alvey-Ferguson Co. utilizes a punched card reader in order picking. Desired quantities of items from 72 storage areas can be picked and assembled into orders automatically.

▶ Production Control

Production control is a further extension of inventory control and makes use of inventory figures to control or schedule production. The simplest type of production control is low-level indication. Assume a manufacturer of 60 types of products can only make 10 types simultaneously. He wants to know when his inventory in any type reaches a preset low level so he can switch production to that product. This control can be accomplished by one limit switch in each storage line operating a remote indicating light, or by receiving signals from counters associated with each line.

A more elaborate system of production control may use inventory figures read out on demand to adjust production during the day, or a complete inventory readout at the end of each day on which to base the next day's production schedule. The most elaborate approach would be a system with a computer combining inventory data with orders-received data to compute production schedules. This same computer could be the heart of the control system that would be needed to automatically dispatch, store, and pick orders.

▶ Billing Control

The data processing function of billing control is most closely associated with systems incorporating order picking. Information is readily available in the control system detailing the order and the actual items shipped (the order less stock shortages). By adding equipment to type out this information, lists can be automatically made of items ordered, order shortages, and items shipped. With the addition of computing equipment, or further programming of a computer already in use, the entire invoice can be typed out including the unit prices and the total.

All of these three data processing functions are partially accomplished by the control equipment needed to control the material flow. In most cases, the addition of some type of readout equipment will be all that is necessary to upgrade the system and provide the added function. For this reason, a systems engineering study must consider not only the functions desired by the customer at present, but also any future functions the customer has indicated he may want to add. An idealized, but feasible, automated materials control system is illustrated in the box entitled "Integrated System."

▶ Economic Benefits

Many material handling systems can benefit from automation. In these cases decisions must be made concerning which operations to automate and to what degree. For the most part the major factor in these decisions is dollar savings. These dollar savings, considered with respect to the investment to automate, give return on investment (per cent) or payoff (years) as an indication of the savings or benefits to be effected.

Dollar savings are most likely to appear in the following areas:

1. Reduced labor costs in both the warehousing and office operations.

2. Reduced inventory which results in a saving of storage space and a savings resulting from reduced investment in inventory.

3. Reduced losses of goods being handled by reducing damage, spoilage, and pilfering.

4. Reduced shipping charges because of better correlation of orders and better utilization of transportation facilities.

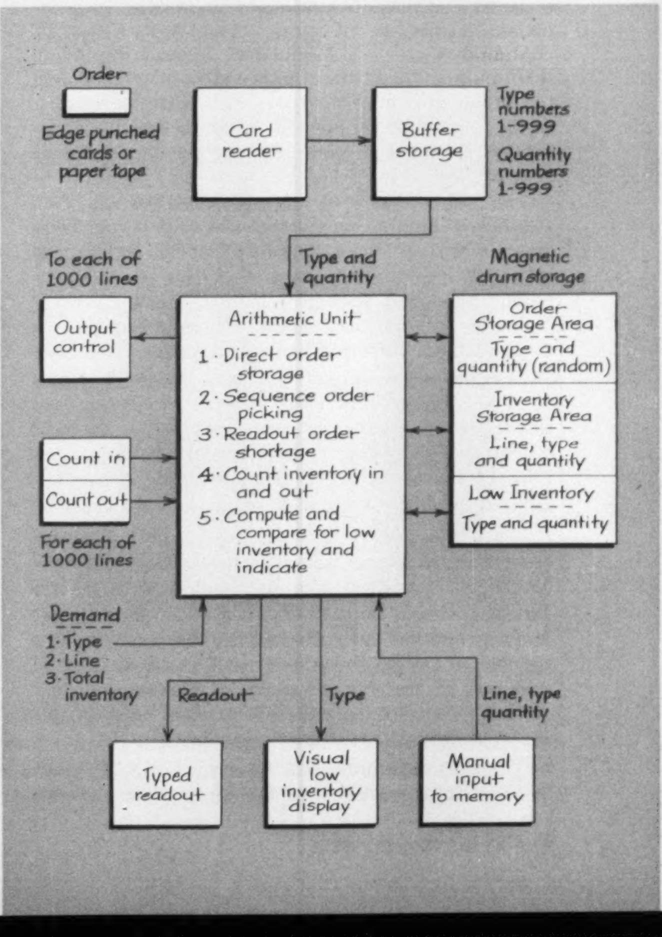
5. Reduced production costs derived from better production planning and control.

6. Reduced operating costs because of less stringent lighting and heating requirements in areas formerly containing workers.

7. Reduced storage floor space due to better utilization of the cube by reduction of aisle space and increased use of overhead areas.

The payoff or return on investment figures weigh most heavily in the decision to automate but they are not the whole story. Many of the benefits of automation cannot easily be assigned dollar values and yet they are equally important to the success of the business operation.

Most notable of these is improved customer service. This basically stems from reductions in the delivery time of orders. Improved production scheduling, faster order picking, and automated paperwork are factors that work toward reducing the order-to-billing cycle. This faster service, in turn, enables the customer to reduce his inventories on hand with the associated benefits repeated to him. The aid to management of having current and up-to-the-minute data on their operation is valuable. Continuous accurate figures on production, inventory, orders, and shipments can take much of the guesswork out of many business decisions.


Order
Edge punched cards or paper tape
Card reader
Buffer storage
Type numbers 1-999
Quantity numbers 1-999
To each of 1000 lines
Type and quantity
Magnetic drum storage
Output control
Arithmetic Unit
1 · Direct order storage
2 · Sequence order picking
3 · Readout order shortage
4 · Count inventory in and out
5 · Compute and compare for low inventory and indicate
Order Storage Area
Type and quantity (random)
Inventory Storage Area
Line, type and quantity
Low Inventory
Type and quantity
Count in
Count out
For each of 1000 lines
Demand
1 · Type
2 · Line
3 · Total inventory
Readout
Type
Line, type quantity
Typed readout
Visual low inventory display
Manual input to memory

INTEGRATED SYSTEM

AN ULTIMATE automated materials control system—one that includes all 8 functions of identify, dispatch, store, recall, delivery, inventory control, production control, and billing control—can be illustrated by a proposed installation for an automotive parts manufacturing company.

Each day, 20 to 30 types of items are scheduled for production. As they are produced, each type is accumulated on separate buffer storage conveyors. As a train of a certain type of item is formed, the dispatch operator interrogates the storage memory equipment to determine how many units can be accepted by each line assigned to that item.

When the desired number of units has been accumulated on the buffer storage conveyor, the operator releases them onto the dispatch conveyor. He assigns an electrical code to the train which identifies the exact storage line the train is to enter. The train tripping the limit switch prior to entering the storage area causes the destination code to be inserted into the shift register memory input.

Ten check points (representing 10 zones into which the 5 storage areas are divided) are provided along the dispatch conveyor. At a check point the code assigned to the train is compared with the codes of the 100 lines within the particular zone. If the train code is the same as one of the line codes, the proper diverter mechanism is actuated and the train enters storage. If none of the codes are the same, the train proceeds to succeeding check points until comparison is obtained.

One check point per zone of 100 storage lines minimizes the number of shift register banks required (normally one shift register bank is used for each discharge lane). Since the check point limit switches are located about 200 feet apart, and since two trains cannot be allowed to be in a zone at the same time, there must be a space of at least 200 feet between trains. As a train enters a storage line, limit switches pulse the item count into the magnetic drum which keeps a running account of the number of items in each storage line.

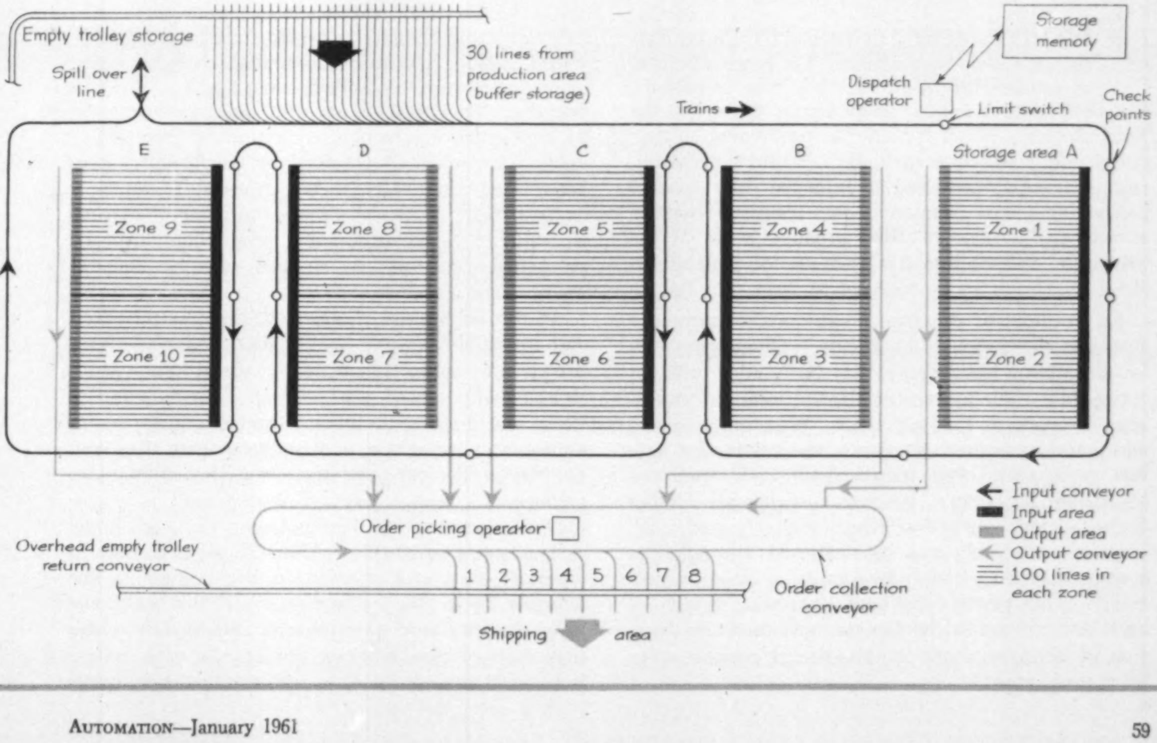
Items are recalled from storage on five conveyors simultaneously (one from each storage area) to fill orders. Order picking is initiated by an operator inserting a stack of punched cards in a card reader. The data from the cards are recorded in temporary drum storage. After the order is recorded, logic circuits cause the items to be discharged from storage on the five conveyors simultaneously. In each storage area the discharge sequence is from the nearest storage line to the farthest from the order collection conveyor in order to prevent interference on the collecting line. The proper quantity of each item is counted out and a signal provided to stop movement of items on the storage lines at the predetermined quantity.

The ordered items automatically flow from the storage area to an exit where they make the transition to a common order collection conveyor. At this point, the order picking operator manually selects an exit station on the collection conveyor into which the order is to be diverted.

In the event there is not enough of a particular item to fill an order, a signal is registered indicating this condition along with a visual indication of the item and quantity of shortage. The operator records the shortage and then pushes a reset button to allow the order picking in that storage area to continue.

Limit switches pulse the recalled item count into the magnetic drum to subtract those items from the previously stored quantity. At the end of specific time periods (or on demand) the inventory record can be read out and typed. This inventory record can be used to aid in planning the production for next day.

Low level inventory is displayed visually when the inventory quantity falls below a pre-established minimum quantity. Each order can be typed out with provision for automatically computing and typing out the bill.



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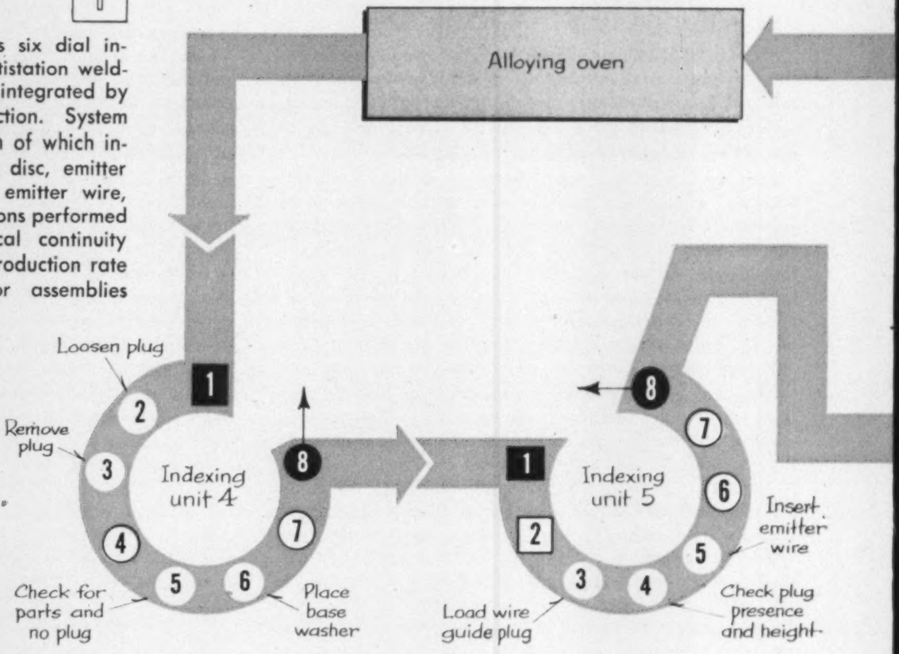


Transistor assembly system includes six dial indexing units, two ovens, and a multistation welding machine. Production units are integrated by belt conveyors that provide float action. System produces transistor assemblies, each of which includes a collector dot, germanium disc, emitter dot, base washer, collector wire, emitter wire, and prefabricated header. Operations performed include alloying, bonding, electrical continuity checking, forming, and welding. Production rate of the system is 2500 transistor assemblies per hour.

AUTOMATION TODAY

PRODUCING TRANSISTOR ASSEMBLIES

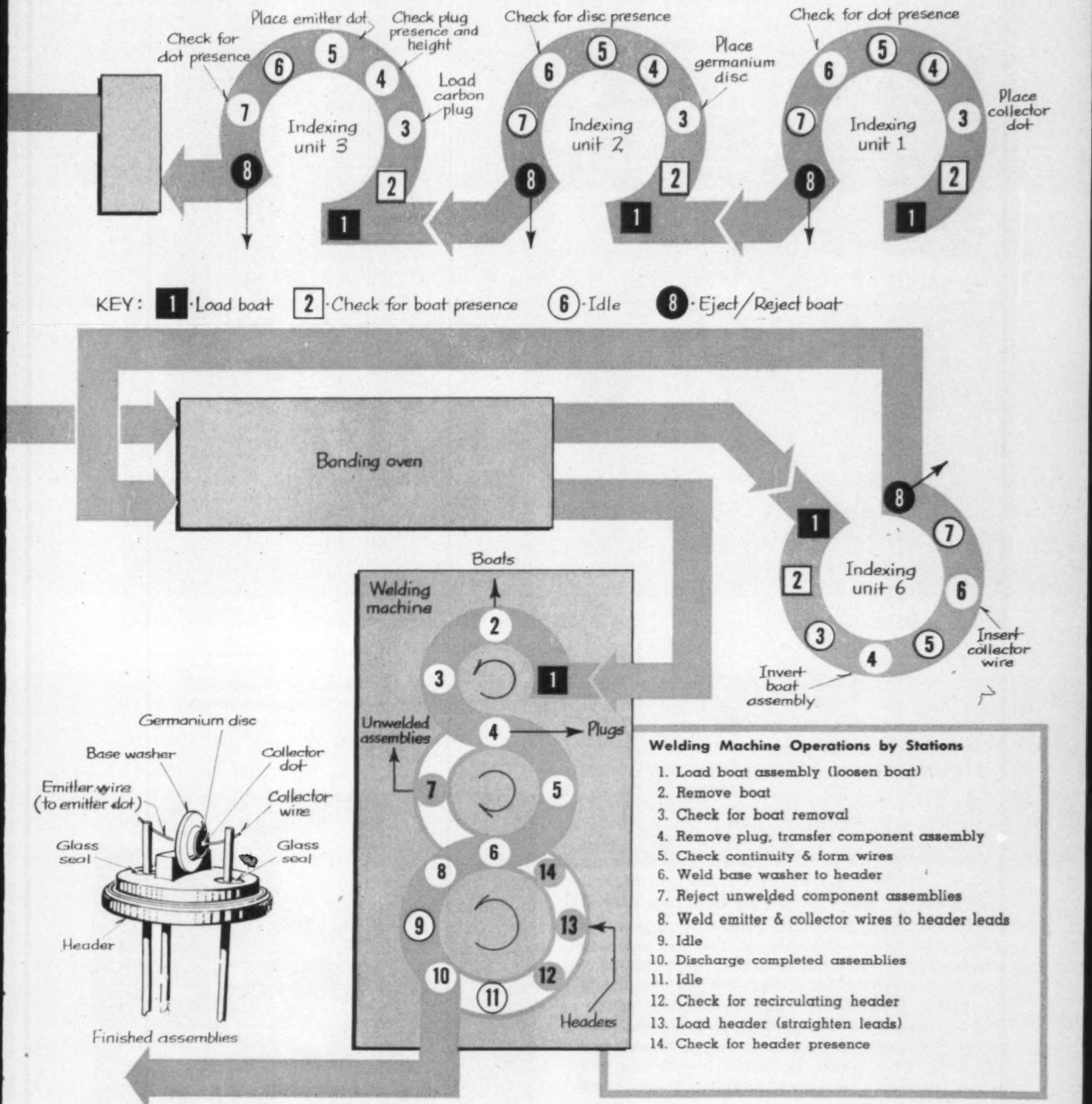
TO HELP MEET International Business Machines Corp. requirements for large numbers of reliable, uniform, and low cost transistors, the IBM manufacturing engineering group at the Poughkeepsie, N. Y., plant is developing highly automated production methods. While the specialized equipment produced is intended only for the production of the company's own transistor requirements, and is not an IBM product, some of the principles and philosophy used are of general interest.

An example of the type of automatic equipment that was developed is an in-line production system for assembling basic elements of NPN alloy junction transistors. The system originally produced assemblies at a rate of 1800 per hour. With prove-in and additional operating experience, the production rate has since then been increased to 2500 transistor assemblies per hour. Because a sequential (rather than a batch) method of manufacture is used, each transistor assembly can be followed through the process and inspected individually as often as necessary. This permits checking of product quality at each critical step in the process and automatic rejection of defective work at the earliest possible stage of manufacture.

Major equipment items in the transistor assembly system include six multistation dial indexing units, two temperature controlled ovens, and a welding machine. These production units are interconnected by belt conveyors to form a continuous line. Automatic float action is obtained by permitting a predetermined number of parts carriers to accumulate on each belt. When the proper number of carriers is available at the input of a production unit, the preceding unit will be stopped until a demand signal is received.

At the beginning of the line, three multistation dial indexing units, using Ferguson Machine Corp. drives, are connected in series. Each dial carries eight equally spaced workholders. The function of these machines is to prepare prefabricated components—a collector dot, a germanium base disc, and an emitter dot for each transistor—for alloying in an oven.

At Station 1 of the first indexing unit, machined carbon parts carriers, or "boats," are fed from a vibratory tray and inserted in the holders in the indexing table. In the feeding cycle, the boats pass from the tray onto a transverse, endless belt where they form a line between guides. As each holder is indexed into position, a reciprocating bar inserts


Place emitter dot
Check plug presence and height
Check for dot presence
Load carbon plug
Indexing unit 3
Check for disc presence
Place germanium disc
Indexing unit 2
Check for dot presence
Place collector dot
Indexing unit 1
1
2
3
4
5
6
7
8
KEY: 1 · Load boat 2 · Check for boat presence 6 · Idle 8 · Eject/Reject boat
Bonding oven
Indexing unit 6
Insert collector wire
Invert boat assembly
Boats
Welding machine
Unwelded assemblies
Plugs
Headers
9
10
11
12
13
14
Germanium disc
Base washer
Collector dot
Emitter wire (to emitter dot)
Collector wire
Glass seal
Glass seal
Header
Finished assemblies

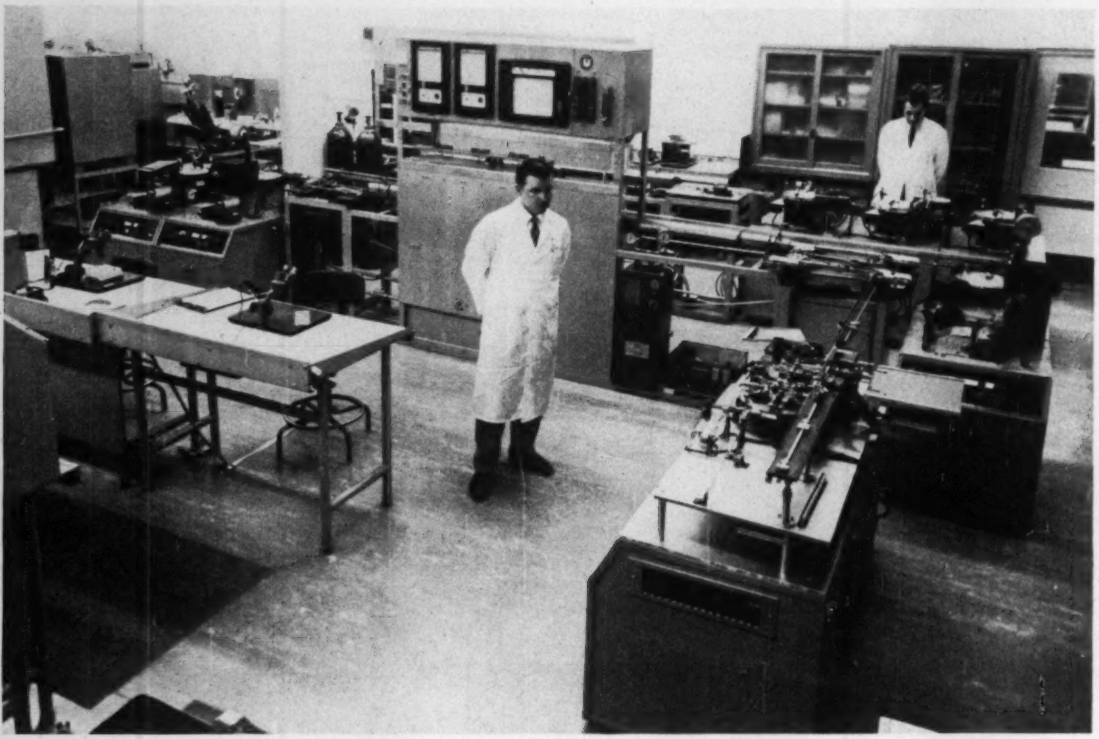
Welding Machine Operations by Stations

1. Load boat assembly (loosen boat)
2. Remove boat
3. Check for boat removal
4. Remove plug, transfer component assembly
5. Check continuity & form wires
6. Weld base washer to header
7. Reject unwelded component assemblies
8. Weld emitter & collector wires to header leads
9. Idle
10. Discharge completed assemblies
11. Idle
12. Check for recirculating header
13. Load header (straighten leads)
14. Check for header presence

the leading boat in line into the holder.

Detection of missing boats in holders is accomplished by a circuit including a photocell and light source at Station 2 of the first indexing unit. If a boat is missing in a holder, a collector dot will not be fed at the next station. If a boat is present, at Station 3 a collector dot is placed in the boat by a shuttle feeding mechanism and positioned by vacuum applied to a hole in the bottom of the boat. A photoelectric check is next made for the presence and proper positioning of a collector dot in each boat at Station 6. The checking arrangement includes a light source above the table and a photocell below. A properly positioned collector dot will prevent the light beam from reaching the photocell through the hole in the boat. Acceptable boats are ejected to a belt conveyor at Station 8 for transfer to the second indexing unit. Boats in which the dots are missing or improperly located are rejected automatically from the line at this station.

Boats containing collector dots are fed to Station 1 of the second indexing unit. After a check for



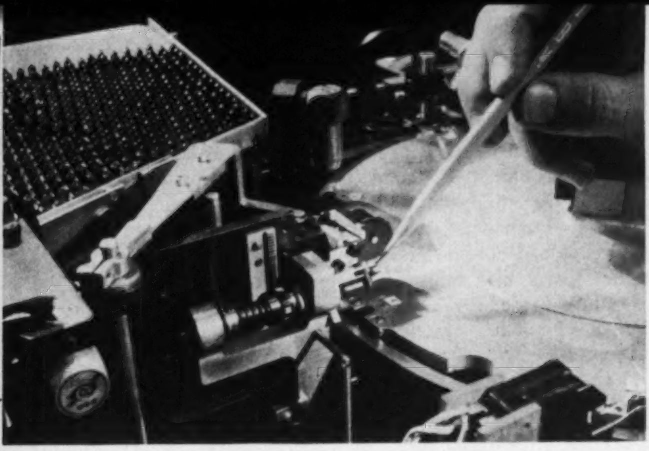
2

Over-all view of installation shows layout of transistor assembly equipment. Operations begin on series of three indexing units in front of attendant, right background. Finished transistor assemblies are discharged from welding machine, right foreground. Tables containing microscopes, left, are used for final inspection of products assembled by the system.

presence of a boat in each holder at Station 2, a germanium disc is dropped into each boat at Station 3 of this unit. Feeding will not occur unless a boat is present. Disc feed is accomplished by a vibratory bowl feeder which removes broken discs, chips, and other small particles. Discs pass from the bowl of the feeder onto tracks for pickup by a vacuum probe. The design of the tracks includes provision for preventing out-of-limits, soiled, and overlapping discs from reaching the pickup point at the end of the tracks. Inserting of a disc in a boat is accomplished when the vacuum probe picks up the leading disc in the track, moves it over a funnel, and releases it to a boat. At Station 6, presence and proper positioning of germanium discs in boats are

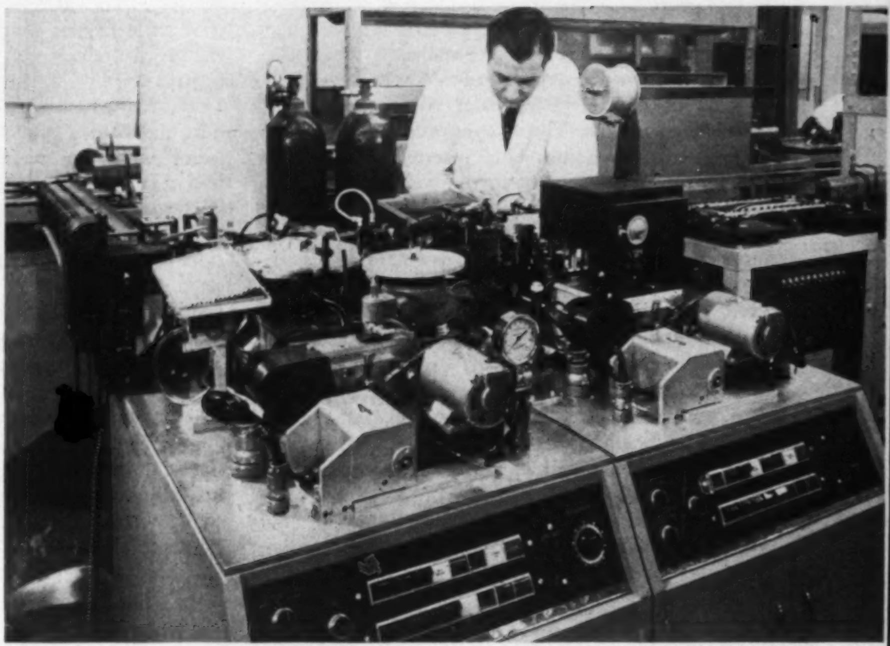
3

Machined carbon parts carriers, or "boats," are loaded in the first dial indexing unit, foreground. After receiving a collector dot, boats are discharged onto conveyor for transfer to second dial indexing unit where a germanium disc is added. In third indexing unit, an emitter dot is placed on top of germanium disc. Boats containing the three transistor elements in proper positions are then transferred to oven, background, for alloying.



4

To facilitate loading and positioning of tiny emitter dots at Station 5 of the third indexing unit, a carbon plug is inserted in each boat at Station 3 as shown. Plug has funnel-shaped internal passage to guide the dot into position over germanium disc previously added to boat. Plugs remain in the boats during alloying operation in oven and are removed on a fourth indexing unit.



5

Boats containing alloyed collector dots, germanium discs, and emitter dots move from alloying oven, background, by means of belt conveyor, left, to indexing units, foreground. In first indexing unit, left, the carbon plug is removed and a base washer is added to each alloyed assembly in a boat. In second indexing unit, right, a wire guide plug is placed in each boat, and a wire is inserted in the plug to contact the emitter dot in the boat. Wire, supplied from a spool, is automatically fed into an axial hole in the guide plug and cut off.

checked photoelectrically. Boats with discs in place are placed on a conveyor and rejects are removed from the line at Station 8.

The third component for alloying—an emitter dot—is placed on top of the germanium disc in each boat in the third indexing unit. After a boat has been loaded at Station 1 and its presence detected at Station 2 of this unit, a carbon plug is inserted in the boat at Station 3. The purpose of this hollow plug is to guide and support the emitter dot in position over the germanium disc. At Station 4, presence and height of plugs in the boats are detected photoelectrically. Emitter dots are dropped into the funnel-shaped plugs at Station 5, and their presence and positioning are detected photoelectrically with a reflected light arrangement at Station 7. Another sorting operation at Station 8 rejects improper assemblies.

Acceptable boats are next transferred to an oven belt and conveyed through a multizone oven where the parts are alloyed. After passing through a cooling zone at the exit end of the oven, the boats and their contents are discharged to a wide belt leading to a fourth indexing unit. Capacity of the belt is such that it can be used for temporary storage of the boats from the oven.

Boats containing plugs and alloyed assemblies are loaded at Station 1 of the fourth unit and indexed to Station 2 where the plugs are broken loose. The plugs are removed at Station 3 of this unit. At Station 5, a photoelectric check is made to determine that the plug has been removed from each boat and the boat contains an alloyed assembly. At Station 6, base washers are fed on tracks from a vibratory bowl feeder to a loading position. There, a vacuum device picks up a base washer and places it on top of the alloyed assembly in each boat. An eject/reject cycle occurs at Station 8.

Boats ejected from the fourth indexing unit are conveyed on a belt to Station 1 of a fifth unit. Presence of a boat is checked at Station 2, and a wire guide plug is inserted in each boat at Station 3. Plug presence and height are checked at Station 4. An emitter wire is fed from a spool into the wire guide plug and cut off at Station 5. A hole through the center of the plug guides the end of the emitter wire into contact with the emitter dot in the boat. Ejected boats are next moved to a bonding oven on a series of conveyors.

As each boat proceeds through the oven, the emitter wire is bonded to the emitter dot, and the base washer is bonded to the germanium disc. Cooled boats and parts then move to a sixth indexing unit to receive a collector wire.

Boats loaded at Station 1 in the sixth unit are checked photoelectrically for presence at Station 2. At Station 4 of this unit, the entire assembly—boat, emitter wire guide plug, and bonded and alloyed parts—is inverted in its holder. At Station 6, a collector wire is prepared and inserted in a hole in the inverted boat until contact is made with the collector dot. After they receive collector wires, the boats are returned to the bonding oven for a second pass in which the collector wires are bonded to the collector dots. The alloyed and bonded components, still in boats with inserted wire guide plugs, are next transported to the welding machine.

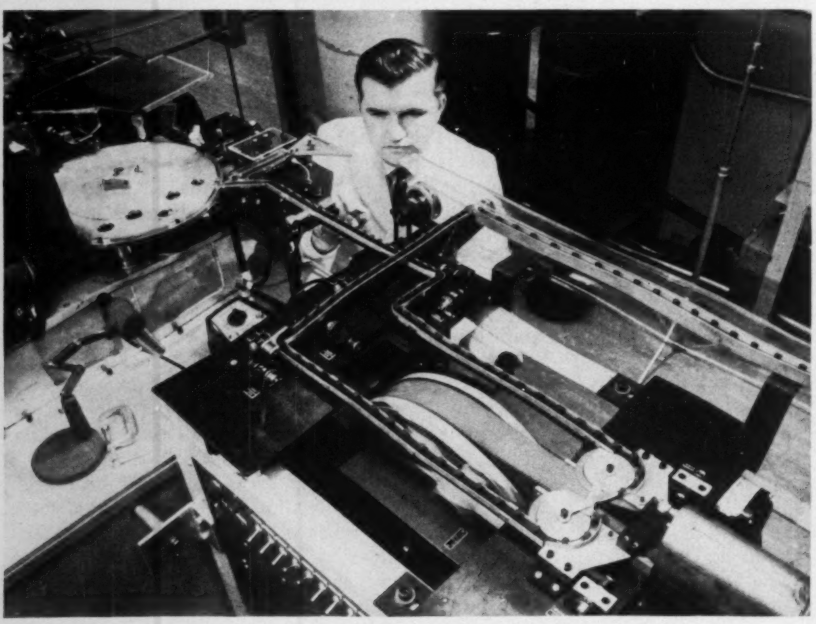
Function of the welding machine is to test each alloyed and bonded component assembly, form the emitter and collector wires, and assemble a header, or base, by welding. Basic elements of the machine include three dial indexing tables.

In the first indexing table, inverted boat assemblies are loaded and the boats are loosened from the plugs at a loading station. The boats are removed at the next station. An inspection station then checks that boats have been removed. At a final station of the first table, the component assemblies are lifted from the plugs by a tweezer arrangement. Plugs are ejected at this station, and component assemblies are transferred to an adjacent station on the second table. After an electrical continuity check and wire-forming operation at the next station on the second table, the component assemblies are indexed to a welding station where the base washer is welded to a projection on a header. Headers are moved into position at this point by the third indexing table. The headers were manually loaded into magazines serving this table.

If a component assembly passes the continuity test, its base washer will be welded to a header on the third indexing table. Thereafter, the combination of elements will travel on this unit. If the component assembly fails the continuity test, welding will not occur, and the component assembly will be retained on the second indexing table for rejection at the next station. When a weld does not occur, the header that was indexed into position on the third indexing table recirculates automatically on this unit.

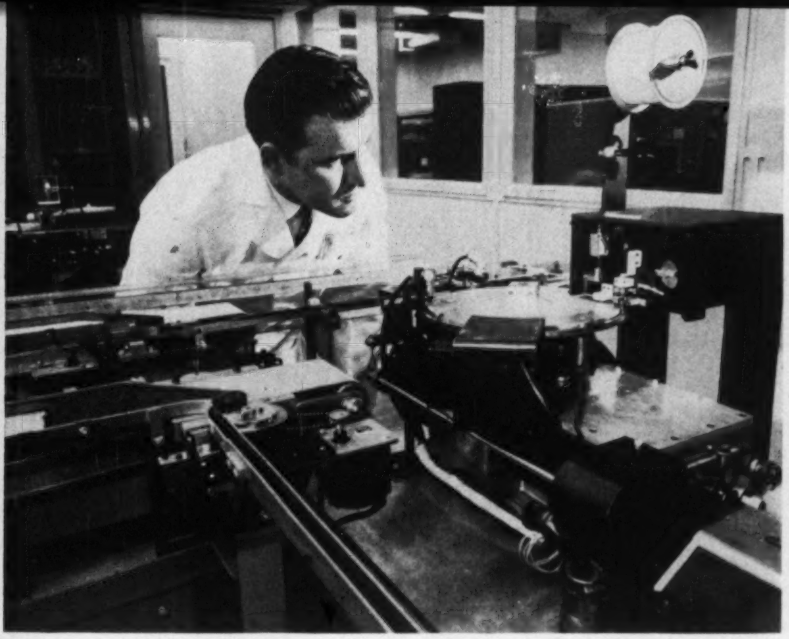
Welded assemblies on the third indexing table next move to a station where the emitter and collector wires are welded simultaneously to header leads. In this operation, the assemblies are rotated 90 degrees. At a following station on the third table, transistor assemblies are discharged onto carriers for manual handling. In subsequent processing steps, the units are etched, tested, and capped. Test results determine the use categories of the completed devices.

Several types of interlocks are provided to ensure safe operation of the system at its maximum production rate. For example, where boats (or boats and plugs) may be too high in their holders, causing damage to themselves or the mechanisms, height is sensed with limit switches. In checking that a base washer has been picked up by the vacuum probe at Station 6 of the fourth indexing unit,



6

Boats that have received wire guide plugs and emitter wires move from indexing unit, left, to bonding oven. Inbound movement for this first pass of boats through bonding oven is on conveyor near attendant's hand. In temperature controlled oven, emitter wires are bonded to emitter dots. Upper conveyor belt system is used to route boats through oven a second time for bonding of collector wires to collector dots.



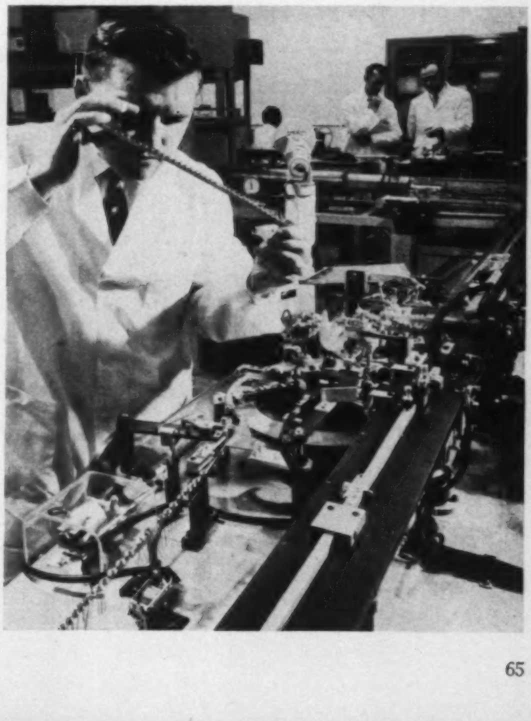
7

Following bonding of emitter wires to emitter dots, boat assemblies are transported on the wide belt conveyor, left background, to the indexing unit on the right. Here, each boat assembly is inverted in its holder, and a collector wire is added through a guide hole in the bottom of the boat. Inverted boat assemblies are then conveyed back to the bonding oven, out of picture on left, where the collector wires are bonded to collector dots. Upon leaving the bonding oven, the assemblies collect on the wide conveyor belt in the left foreground where they are escaped individually into the single track conveyor, foreground, leading to the multistation welding machine.

a vacuum switch is actuated if no part is present on the probe during the placing cycle.

Photoelectric detection is used throughout the system for a variety of checking functions. For example, the presence of parts in feed tracks, of boats on conveyors or indexing units, and of parts properly placed in boats, are checked at various locations by this means. In checking for proper assembly of parts in boats, two principles are used. Where a light beam may travel vertically through a boat with no part present, a light source is used above the table and a photocell is placed below the table as at Station 6 of the first indexing unit. A part must be present in the right position to interrupt the light beam. Where no light can pass through a boat, a reflection principle is used in which the light source and photocell are placed on the same side, and light from the source must be reflected from the part to the photocell.

Rejection of boats from the indexing units is accomplished by a relay and cam switch memory circuit. If, for example, a germanium disc has not been added to a boat at Station 3 of the second indexing unit, the relay system will retain this information, and the cam switch will actuate a solenoid to reject the boat when it has been indexed to Station 8. Boats containing parts in the proper positions are allowed to proceed on a belt conveyor to the next indexing unit. An elapsed-time device is reset each time a boat is accepted. If a certain number of boats is not accepted consecutively within a preset operating time period, the timing device will run out, and the machine will be stopped.



8

Boat assemblies discharged from bonding oven after their second trip through this unit move on conveyor belt to multistation welding machine, foreground. Operations performed automatically in welding machine include removal of boats and plugs, continuity checking of alloyed and bonded assemblies, wire forming, and welding of wires to header leads. Headers are loaded manually in magazines and fed automatically to dial indexing table. If continuity check indicates a defective alloyed and bonded assembly, welding will not occur and header will recirculate on table until it receives an assembly. Completed transistor assemblies are discharged onto carriers for final inspection. Subsequent operations include etching, testing, and capping.

From experience, large companies know that it is feasible to use smaller computers as auxiliary systems for their large-scale computer installations. Here the author discusses a similar concept geared to the needs of smaller companies: A large-scale computer can be shared as an auxiliary system to complement small-scale computer installations.

FUTURE IS BRIGHT FOR

EDP IN SMALLER COMPANIES

By **ALLEN M. FLEISHMAN**, Manager, EDP Methods, Electronic Data Processing Div., Radio Corporation of America, Camden, N. J.

FIFTY YEARS ago, the owner of a large business could call his assistants together and iron out problems on the spot. If he used market surveys, production schedules, or inventory controls, they were pretty crude when compared with today's standards. All things considered, the business world of fifty years ago represents an idyllic time to which we can never return. The nature of business has changed and is still changing. As we try to keep pace with our leap-frogging technology and the new products it creates, our rapidly changing and expanding markets, our mass production and mass marketing techniques, and the tremendous growth generated by these forces, we find that yesterday's business methods are just not good enough and today's are not the final answer.

As an illustration of the rapidly changing business world, consider electronic data processing (EDP). Fifteen years ago, the electronic computer was considered a scientific curiosity. By 1950, EDP sales came to $10 million. Today, that figure has jumped 50 times to over $500 million and by the end of 1970, total data processing revenues are estimated at over $2 billion.

Why has electronic data processing grown so rapidly? The big reason is the great need for it. Business enterprises, large or small, are now characterized by a separation of functions and operations with each function or operation blended into the total "mix" needed by the company to plan, to produce, and to market its products profitably.

Information Is Important

What holds these enterprises and their many separate functions together is information—the constant flow of information from department to department, from division to division, from plant to warehouse, from department head to management, and so on. This flow of information is the nervous system of modern business that provides the coordination of functions and operations. But without help, that nervous system cannot meet the crushing demands of today.

Production needs sales and marketing statistics, sales needs production and inventory information, marketing needs sales statistics and market forecasts, engineering needs sales reports for product research, and accounting needs all of these pieces of information.

Without EDP, each unit collects its own data

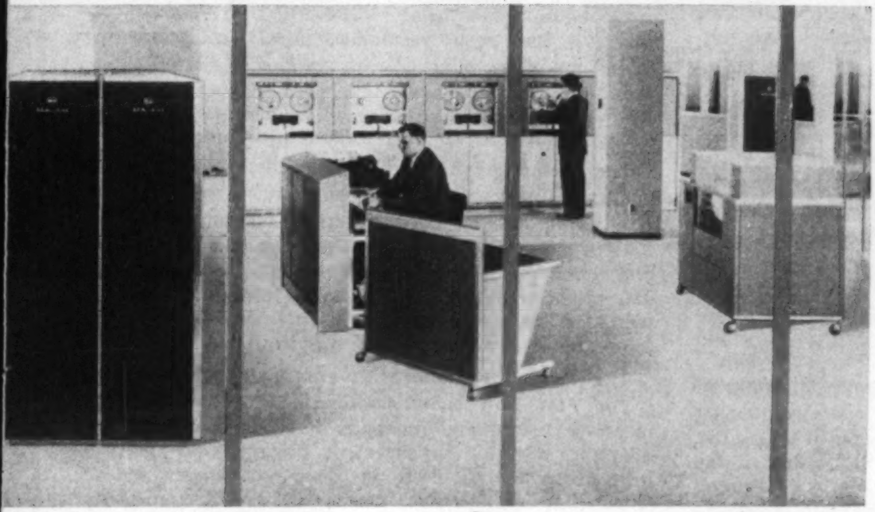


Fig. 1—As seen through display windows, an electronic systems center involves a large variety of data processing equipment. Such centers offer smaller manufacturers the opportunity to share the advantages of large computer installations at reasonable costs. This particular RCA center, located in New York City, is built around an RCA 501 computer.

for its purposes, and each has a clerical staff to accumulate, file, and sort information without end or limit to duplication. Then these facts proceed to clog the channels of information as they are bounced from one place to another and get filed countless times.

Recently, one of RCA's analysts made a survey of paperwork in a medium-large company. Here is what he found: Each order received produced over 200 prepared documents and involved 1750 individual process operations. From 75 to 100 individuals might handle each order at least once and, in some instances, two or three times. These people were required to transfer some 246,000 digits from one paper or card to another, with a chance of error at each point of transfer. The trail of one order could be found in no fewer than 25 files and, depending upon circumstances, in as many as 50 files.

Analysis of the related filed documents showed that 20 per cent of the data stored was common to all files, 60 per cent to four out of every five files, and 90 per cent to three out of five files. Each division or suboperation may use similar sets of basic data, but each uses them for different purposes. This is a specific instance. However, the same picture is seen when you look at the problem with broad perspective.

In the past fifty years industrial production in this country has increased 700 per cent with an 80 per cent increase in factory workers. By con-

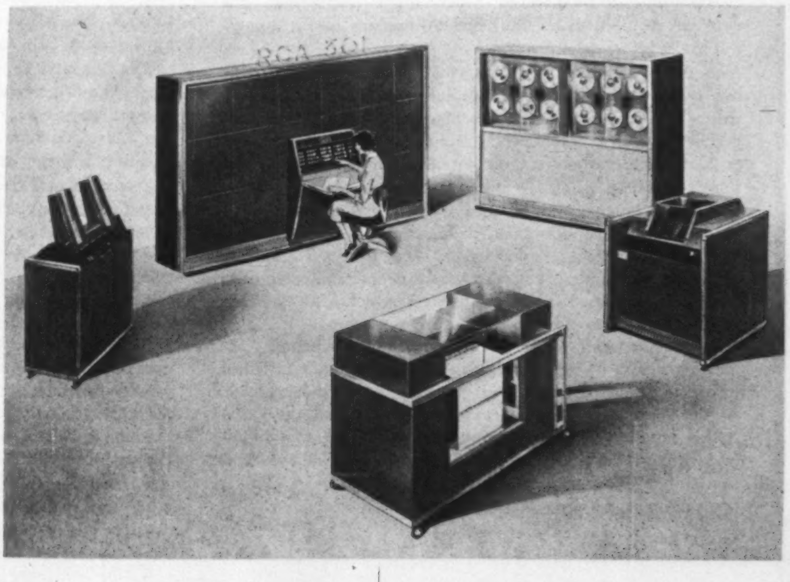


Fig. 2—The RCA 301 electronic data processing system is designed to meet the needs of manufacturers with moderate volume data requirements. The system can be placed into service initially with only input/output equipment, storage devices, and simultaneous control; additional equipment can be added as needed. Such small-scale systems are also potentially useful as auxiliary systems to support large-scale systems.

trast, the clerical force has risen some 450 per cent and it nearly doubled in the past fifteen years. Today, the total of white collar workers exceeds blue collar workers. The problem is not limited to large corporations. Indeed, small companies have the same problems on a relative scale.

Three Growth Areas

Before, we mentioned that electronic data processing will grow. *That* electronic data processing will grow is not as significant as *why* it will grow. Certainly, part of this growth will be due to the natural growth of the country during its continuing expansion. But the big push behind data processing lies in other areas: First, the increasing application of data processing systems to help solve the problems of large businesses will be augmented by the addition of small, versatile, and low cost data processing systems that will allow the small company also to enjoy the economic advantages of data processing.

Up to now, small businesses have been able to mechanize only a small portion of their problems because the only equipment available at a reasonably low cost has been electromechanical tabulating equipment. This punched card equipment has provided only a partial solution because it cannot achieve the flexibility needed to handle the wide range of data processing applications encountered.

The second growth area also applies mostly to smaller businesses. The data center concept will provide further use for data processing systems. This concept makes it possible for companies that do not find it economically feasible to purchase or lease a data processor to take advantage of a full blown system at a data processing center. Improved data communication will help make this possible.

The third area, one with enormous potential, is the work now being accomplished by management engineers and methods analysts who are adapting scientific management principles to the inherent power of electronic data processing systems.

The fourth area involves the opportunities made possible by advanced data gathering and data communications equipment. For example, RCA is now working on a variety of new devices which will feed data into computers with greater speed and accuracy, and most importantly, at lower cost. In order to make significant savings in this area, new techniques of data gathering and communication must be de-

EFFICIENT PROGRAMMING

RCA COBOL Narrator is a problem-oriented automatic coding system for RCA 301, 501, and 601 equipment. This system is a product of the RCA advanced programming group and is designed to bridge the gap between the expression of problem logic in English language and the required translation into bit-coded language. Thus, it replaces programming techniques in which input instructions and data are required to be translated by humans into a numerical code before machine use.

Its design evolved from a two-fold purpose: 1. To enable the programmer to use English language flow chart statements to generate complete machine programs directly, thus permitting the programmer to concentrate entirely on the problem logic without having to be concerned with clerical translation details. 2. To allow a problem already defined in English language to be used by any existing equipment or planned computer systems. This would be extremely advantageous during expansion cycles, since it would eliminate costly reprogramming, and also would enable computer users who had similar data processing requirements to exchange programs between various computing systems.

In order to achieve the desired compatibility with all computer systems, definite ground rules had to be established before a common, compatible language could be completed. At the suggestion of the Department of Defense, the Committee on Data Systems Language (CODASYL) was organized in May 1959 to consider the development of specifications for a Common Business Oriented Language (COBOL) for automatic programming of data processing systems.

The committee included representatives from major computer manufacturers and users. This group discussed the experience of users with existing business compiler type routines (techniques whereby detailed computer operations are specified by relatively simple input instructions) and extracted salient features to build a framework for an effective common business language. As a result, a finalized report on COBOL was approved in January 1960 by the Executive Committee of CODASYL. During this time, the RCA 501 COBOL Narrator was designed. Its use has been extended to the RCA 301 and 601.

The Narrator input consists of three main parts or divisions: Environment description, data description, and procedural statements. A brief fourth part, identification, specifies such particulars as program author and date written, etc., enabling a given program to be identified.

Environment Description specifies the equipment configuration for the computer upon which the object program is to be run and, also, information concerning rerun and file selection. In a sense, it specifies the "outside world" to the computer.

Data Description consists of entries which describes files, records, working storage, and constants, all of which are to be manipulated by the object program according to the steps outlined by the Procedural Statements. This division, then, relates the mapping of the data within the computer or the "inside world" to the compiler.

Procedural Statements allow the specification of the steps for problem solution to be expressed in meaningful English. This includes the concept of *verbs* to denote actions, *sentences* to describes procedures, and *IF clauses* to provide alterveloped. These techniques may or may not involve data processing systems, but they will certainly involve the ingenuity of management who will be applying their talents to problems such as this.

▶ Learning About Computers

Because computers were first viewed as expensive experimental tools for long-haired engineers, there is a certain mystery about their operation and use. To complicate the matter, a combination of engineering and mathematical skill produced the first practical data processing computer. And anything touched by mathematics is usually judged as belonging to another world. But understanding and managing a data processing system involving a computer is just not that difficult. In fact, it isn't difficult at all, although obviously effort is required.

A necessary first step for the manager who is not yet well-versed in data processing is to develop his abilities. This will require a good bit of self study, but technological changes are simplifying the task. For instance, it was one time quite difficult to write a program for a computer. This was because the instructions that tell the machine what to do and when to do it were prepared in a code that the machine could interpret. But only the machine and its programmers knew this code. And learning the code was not easy and it varied considerably between computers even of the same make.

Now, however, some computers can interpret an input written in everyday language. This simplified programming system is called COBOL—Common Business Oriented Language. The box entitled "Efficient Programming" discusses the system in more detail.

An important method for learning about computers is the company seminar which provides open forum discussions of the latest techniques being developed in a wide range of applications, especially in manufacturing and other commercial business activities.

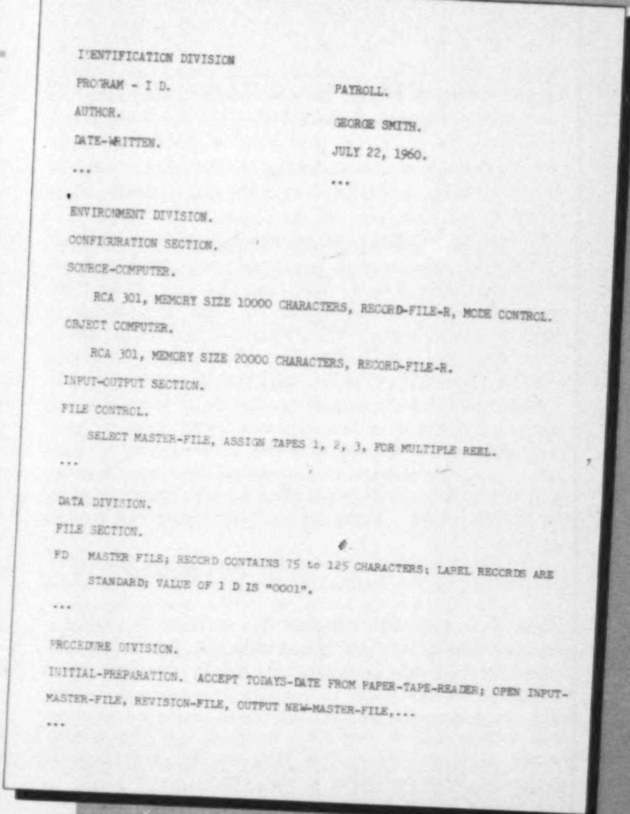
Another approach is to visit data processing installations. Many of the companies who have installed data processing systems are only too glad to discuss and explain their approach to data processing. And still another effective way of obtaining knowledge of the data processing field is to write to various manufacturers and ask for literature on both general and specific subjects of interest.

There are approximately 20 companies making digital computers (all data processing of any consequence is carried out on digital machines). These

native paths of action. The RCA COBOL Narrator has approximately twenty verbs, each of which corresponds to a subroutine called a Generator. Verbs used include such words as *accept, move, alter, display, examine, read,* and *write.* The verbs are used by a programmer in writing the English statements which define the procedures the Narrator is to use in automatically preparing the object program for problem solution. During compilation within the computer, the verb calls for its Generator and the Narrator supplies the object of the verb, i.e., its operands, to the Generator as parameters. Thus, each Generator is able to create automatically a set of instructions which will fulfill exactly that condition specified within the English statement.

The operands of the verbs used in compilation, for the most part, can be determined by each individual user. That is, the files, items, and constants are named by the user for his application and are accepted by the Narrator. Of course, each Narrator division has its format requirements which specify where the user's chosen names are to be written. However, the over-all format is essentially a free form. For example, the Procedure division specifies verb formats which show the relative position of the verb, names of data or constants, and both key and superfluous words.

In preparing a program, the programmer establishes a flow chart which describes the problem logic. With this guide he then writes out the program. The words are punched on paper tape by means of a machine resembling a typewriter. Subsequently the words are transferred to magnetic tape and fed into the computer. The following abstracted portion of a program illustrates how a print-out of the program would appear.



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IDENTIFICATION DIVISION
PROGRAM - I D.                    PAYROLL.
AUTHOR.                           GEORGE SMITH.
DATE-WRITTEN.                     JULY 22, 1960.
...                               ...

ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SOURCE-COMPUTER.
    RCA 301, MEMORY SIZE 10000 CHARACTERS, RECORD-FILE-R, MODE CONTROL.
OBJECT COMPUTER.
    RCA 301, MEMORY SIZE 20000 CHARACTERS, RECORD-FILE-R.
INPUT-OUTPUT SECTION.
FILE CONTROL.
    SELECT MASTER-FILE, ASSIGN TAPES 1, 2, 3, FOR MULTIPLE REEL.
...

DATA DIVISION.
FILE SECTION.
FD  MASTER FILE; RECORD CONTAINS 75 to 125 CHARACTERS; LABEL RECORDS ARE
    STANDARD; VALUE OF 1 D IS "0001".
...

PROCEDURE DIVISION.
INITIAL-PREPARATION.  ACCEPT TODAYS-DATE FROM PAPER-TAPE-READER; OPEN INPUT-
MASTER-FILE, REVISION-FILE, OUTPUT NEW-MASTER-FILE,...
...
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manufacturers make data processing equipment which covers a wide range of applications—from small systems which are really an extension of the desk calculator, to large systems like the RCA 601 (a measure of computer size is its rental price for one shift of operation). As a practical working percentage, it might be said that a company with a total clerical expenditure of $50,000 a month for manual data processing could feasibly apply a $10,000 to $15,000 a month electronic system. However, selling price is not the criteria by which to select a system. Some systems at $10,000 a month produce a lower cost per unit of information processed than others at a similar price. Thus, when selecting an EDP system, the amount of work to be done as related to the total cost of the system must be considered.

Today, thousands of large corporations are expanding their electronic data processing operations—adding larger, faster systems for data processing centers and smaller systems for divisional and specialized EDP operations. And, at the same time, smaller businesses are adding the advantages of electronic data processing to their organizations—most for the first time. Behind the entry of the smaller businesses into electronic data processing are a new breed of computers characterized by the RCA 301.

For example, the "compact" RCA 301 was designed with the data processing problems of the smaller business in mind. In creating the system, it was realized that the basic difference between the smaller and larger business is not in the complexity of the data processing problems, only in the volume of data that must be processed.

To meet this need, the new breed of computers offers complete data processing capabilities at low cost to provide the moderate volume business with a complete solution to its data processing problems. The small business is given the same competitive

AUTOMATIC PRODUCTION CONTROL—196?

COMPANY A is not large enough to own its own medium or large scale data processing system. However, it does rent and operate, at the plant level, a fairly small system similar to the RCA 301. This system provides the hour-by-hour needs of plant loading, machine loading, production scheduling and inventory control, on a non-dollar record basis. In other words, the units of measurement are manhours, lapsed hours, units of production, and units of inventory. Company A, through a data processing service contract, has the rest of its daily, weekly, and monthly data processing performed at an electronic systems center.

As new information and parameters enter the business for the first time, such as new employees, names and addresses, and payroll data, new customers, new product descriptions, new inventory items, etc., this information is typed on special forms. These forms are sent to the center where electronic document readers, in accordance with prescribed programming, enter the data in the proper records.

When an order is received in the plant, an abstract of this order is typed on a production order format. As a byproduct, certain selected data are punched into a paper tape. The paper tape enters the required data into the plant computer and transmits certain data by wire transmission to the systems center. These are the only typing and clerical operations.

A typical day goes something like this: Production orders are received by the foreman in the morning. These come from either the systems center, as in the case of inventory orders, from the plant computer, in the case of scheduled customer orders, or from the production order typing for emergency and special orders.

Attached to each order or suborder is a tag which identifies the order. On this tag there is a machine activating code number. Both the plant computer and the systems center computer can quickly translate this number into the proper data pertaining to this order.

A worker arrives at the plant in the morning. He withdraws his in-plant badge from a rack near the door (a source recording device) without having to wait in line to punch a time clock. All recording for attendance and payroll purposes takes place automatically by wire to the center the instant he withdraws the badge. A large group of workers can withdraw badges simultaneously. The production worker proceeds to his production area and receives his first production assignment from his foreman or from an assignment rack, or he goes directly to his normal work station.

Upon the completion of a production operation he returns to the assignment station where he enters his identification badge and the production order identification tag in another source recording device. In some cases, the production worker also enters his production count into the transmitter. He touches a button. At the plant computer, the work-in-process inventory is automatically relieved for the operation completed, and the workload and/or machine load schedules are adjusted accordingly. The computer is ready to reschedule on an optimum basis. All data essential to production control, cost accounting, payroll, and general accounting is transmitted to the electronic systems center. When an operation is completed at the end of the day, the production worker signs off by returning his in-plant badge to the rack.

The next morning the foreman receives the daily report of completed operations and variances. He can call back on any questions immediately. The foreman also receives his production schedule and orders for the day at this time.

At the end of the week the worker receives his payroll check, and all payroll records have been completed. The foreman receives a summary cost report which has applied dollars to his daily unit control or variance report. The shop foreman and plant superintendents and others up the management line also receive their key management reports. By the exception method, the data processing system highlights the important issues without repeating unnecessary detail in all of the reports. All other accounting, statistical card operations, and control data processing are similarly completed automatically.

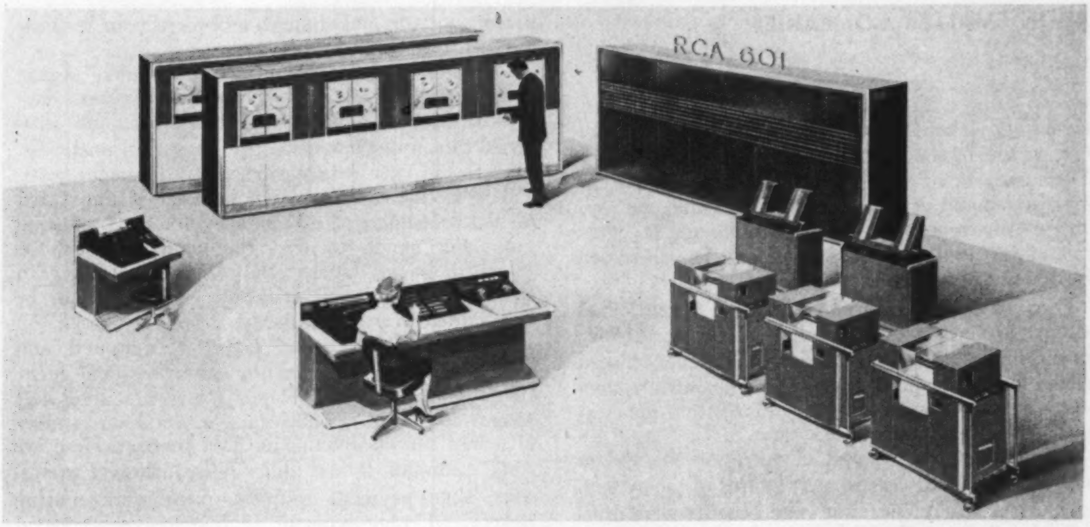


Fig. 3—The RCA 601 electronic data processing system is designed for medium to large-scale requirements. As with other RCA computers, it is [illegible] solid-state system. Anticipating the problems encountered in introducing a computer into use, and the rapid changes being made in the technology, this system can be expanded so far as speed, capacity, or function is concerned.

advantages that formerly have been available only to larger companies that could afford the larger, more expensive computers.

But, even with the breakthroughs in design incorporated in systems such as the RCA 301, the cost of a complete data processing system is still not within the range of every business. There are at least 10,000 companies whose operations do not warrant full-time use of any of the current electronic data processing systems.

For these companies, the answer is the data processing center which provides full data processing services for small companies and back-up support for larger companies. For example, the services offered by RCA's Electronic Data Processing Center include:

1. Performing routine daily and periodical accounting and business office operations, thus reducing tedious clerical chores.

2. Processing data for better and faster management of control and decision making.

3. Helping to tie together interrelated but separated activities within the same corporation.

4. Providing data processing facilities for decentralized divisions or companies which do not wish to set up their own data processing operations.

5. Helping to stabilize costs for companies with large work load fluctuations.

6. Servicing companies requiring data processing facilities for excess volume.

7. Providing an inexpensive indoctrination to electronic data processing for companies of all sizes. Without the center it could cost a company $200,000 and more just to make-ready for data processing before a single button is pushed.

These services will be provided on a regularly scheduled basis, or as special needs arise. Standard rates will be charged for units of work produced. Through such regularly scheduled rates, it thus will be possible for a customer to forecast accurately and control costs. The centers also will operate around the clock, seven days a week. In fact, the busiest time for the centers will be nights and weekends. Transaction data received at the center at 5 p.m. on Monday, for example, will be processed in final form for delivery to the customer by 8 a.m. Tuesday.

As a future improvement, information for data processing will be transmitted by wire to the electronic systems centers from customers' offices, regardless of the distances involved or machinable data in the form of punch cards or perforated paper tape will be used. As another improvement, the routine manufacturing company transactions of time-keeping, production movement, and inventory movement will be gathered by automatic equipment and transmitted by communication systems for automatic conversion to the language of the data processing system.

Pre-Computer Area

With experience it has been realized that EDP itself does not eliminate and reduce paperwork except, possibly, in the accounting and statistical room. These hungry giants devour data in the form of paperwork much faster and in greater quantities than ever before imagined.

This devouring process is called input, and it is in this area, the pre-computer and input area, where the magnitude of paperwork is breaking all-time records. In fact, in most cases, the paperwork is *increasing.* There are two reasons for this increase: First is the increasing awareness of the importance of accuracy in original data. To be practical, EDP systems demand extreme accuracy. Second, the ease with which records can be updated for the preparation of essential management reports has increased the amount of data in the input area.

Prior to EDP, and before the term "input" had become a word in the language of the progressive businessman, the most significant limitation placed on the improvement of a management control system was the cost of obtaining the informative data essential to the success of the system.

In other words, the cost of operating the system had to be weighed against the rewards of the system. In most promising situations the benefits were difficult to evaluate and prove. However, the costs could be determined. As a result, most businesses limited their record keeping to the bare essentials imposed by government regulations and financial requirements.

In manufacturing, the financial requirements, or dollar records, usually took preference over the operating requirements, such as the non-dollar records of production control and inventory control. When the plant manager insisted on adequate operating records and controls, they were often developed by cumbersome manual methods. There was usually no other solution. The controller operated the tabulating department, and financial records—such as payroll, general ledger, cost accounting, accounts receivable, and accounts payable—were naturally taken care of before other requirements could be considered.

The advent of EDP can and is changing this picture. In the first place, modern EDP equipment can handle the complexities of the totally integrated system. An installation requires a large fixed expense so that additional load is relatively less expensive. This, then, is the pay-off. The use of the EDP systems must be expanded to add the importtant nonfinancial applications. The user should constantly strive to reprogram and integrate the more sophisticated applications with the "bread and butter" applications. The key to success lies in the fact that the same input data will often serve both needs. This re-emphasizes that successful systems integration in the future lies in the automation of computer input.

Classification of Input

Input data can be classified into four general categories. The first input category, original and raw data input, may be defined as any permanent or semipermanent file data to be entered into an EDP system, usually only once. To some extent this applies to all EDP installations for data input, such as: New names, addresses, account descriptive data, inventory data, and changes and corrections to these input.

Exhaustive tests have proved that input of alphanumeric data—typed on standard typewriters, verified by special proofreading techniques, and converted directly to magnetic tape by optical reading—can substantially reduce labor and equipment costs.

The second category of input includes the typing of useful documents, and as a byproduct, producing automatic media to feed the computer, such as punched paper tape. The byproduct tape can either enter data into an EDP system direct or be transmitted over any distance.

The third category of input, turn-around and source controlled documents, deserves some mention. Turn-around documents are computer and source controlled documents where a code number identifies the document and data thereon. Here are some examples: Public utility bills, insurance premiums, time payment coupons, piece work routing tickets and other types of work orders, subscription fulfillment bills and renewal notices, automatic credit plan charge tickets, commercial checks, and garment tags.

Again, optical reading offers great promise for turn-around and source controlled documents. The underlying principle of the turn-around document is that only a code number need be recognized upon return of the document. The computer will then look up in its own memory the complete information referred to by that code number.

The fourth and last category of input, automatic source recording, eliminates documents. Data recording, communication, and conversion are automatic. Shop activity recording and point of sales recording are examples of this category.

EDP in Action

An example that ties together most of the important principles is described in the box entitled "Automatic Production Controls 196?"

The procedures of this hypothetical company could take place today. However, this hypothetical system is not now working, nor will it operate in the near future unless an enlightened management makes it possible. An over-all co-ordinating job is yet to be done. Industrial engineers, methods specialists, and members of management can train and sell the production workers, the foremen, the unions, the personnel specialists, the controllers, and management and owners to take advantage of these new tools.

Such a system as is described will truly eliminate a lot of paper work which, though costly, is essential to carry out normal business transactions. All of the equipment described is available today—not necessarily on the shelf, but it can be made available in ample time for possible use in such a modern system. The knowledge of how to work out systems details, and program the EDP equipment is available. However, the over-all capability of putting it all together in a practical installation is missing. Management can supply this missing ingredient.

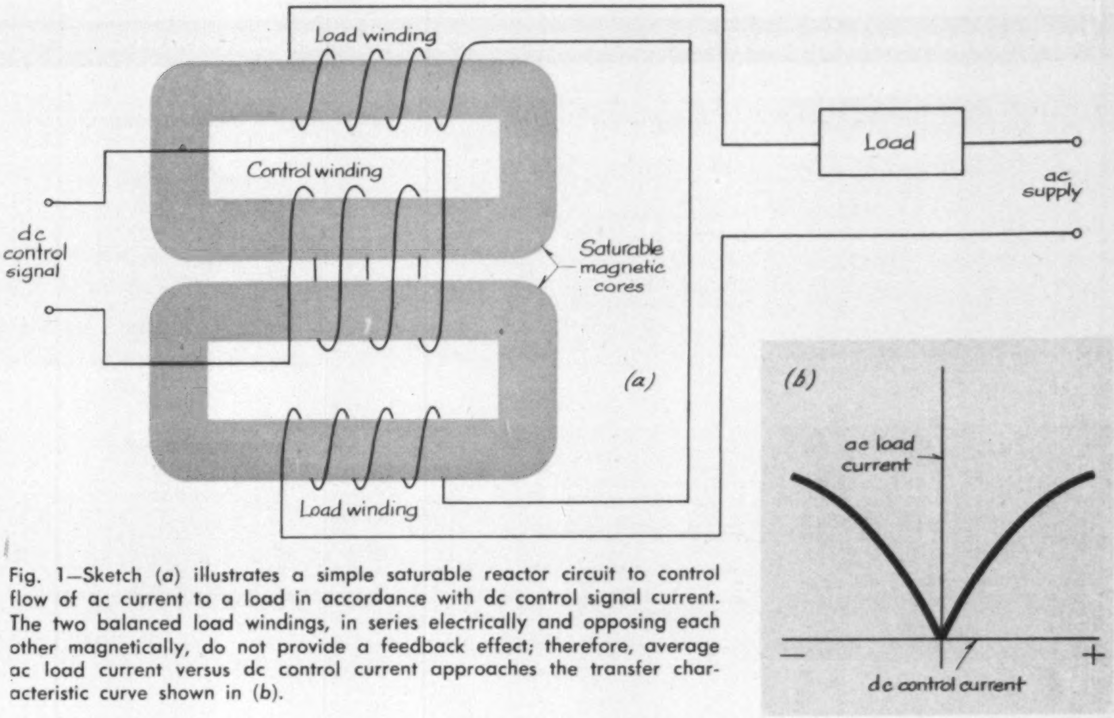


Fig. 1—Sketch (a) illustrates a simple saturable reactor circuit to control flow of ac current to a load in accordance with dc control signal current. The two balanced load windings, in series electrically and opposing each other magnetically, do not provide a feedback effect; therefore, average ac load current versus dc control current approaches the transfer characteristic curve shown in (b).

CONTROL BY STATIC MAGNETIC SWITCHING

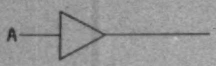
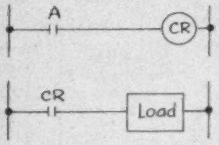
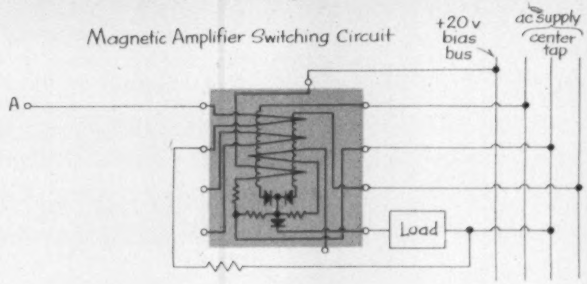
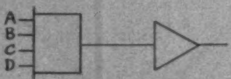
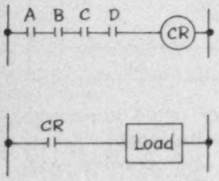
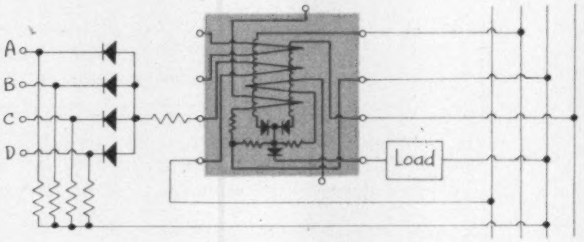
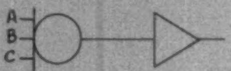
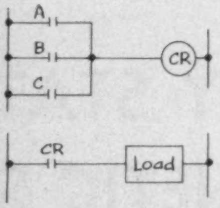
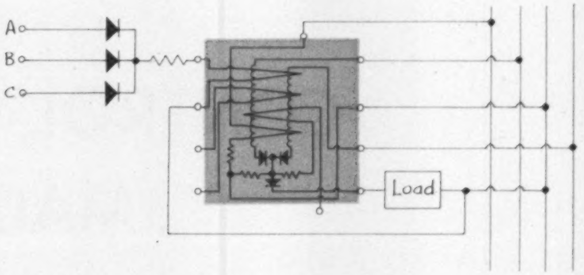
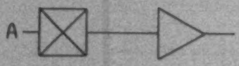
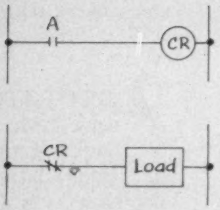
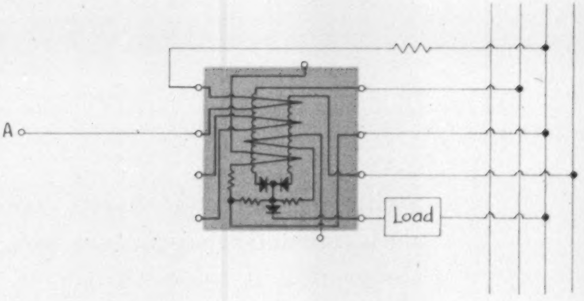
By **BERNARD J. O'NEILL** and **LEE WEISSMAN**
Vice President-Engineering Chief Engineer
Magnetic Amplifiers Div., Siegler Corp., New York, N. Y.

Switching circuits based on static magnetic elements are now performing a wide variety of control functions. The authors discuss fundamentals of static magnetic switching devices and present logic diagrams and circuits using standardized magnetic amplifier modules. Equivalent relay circuits are also shown.

APPLICATIONS in innumerable control systems, both military and industrial, have established the reliability of magnetic amplifiers. Until relatively recently the magnetic amplifiers have been used almost exclusively as proportional devices for amplification of electrical signals in closed loop regulating and servo systems. During the past few years, however, a number of static switching systems based on the use of magnetic amplifier elements have been developed.

Such systems can be inherently rugged and trouble free. Properly designed and applied, they may be expected to perform reliably for an indefinite period under severe environmental conditions. A system of this type can feature fast response, small size of components, and great flexibility. For example, the system developed by Magnetic Amplifiers Div., Siegler Corp., is based on the use of a single basic switching amplifier which is capable of performing a wide variety of logic functions in

TABLE 1—Equivalent Logic, Relay, and Magnetic Amplifier Switching Configurations for Common Functions

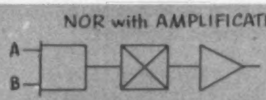
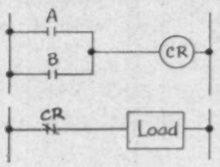
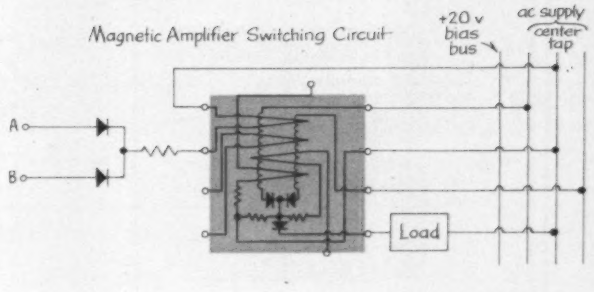
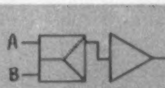
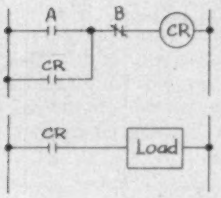
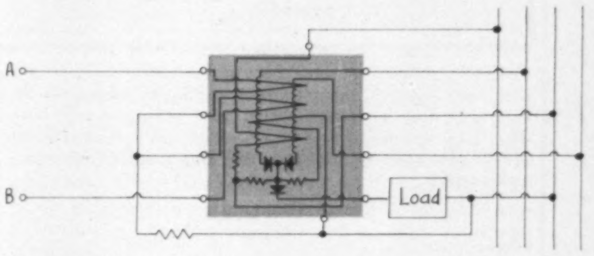
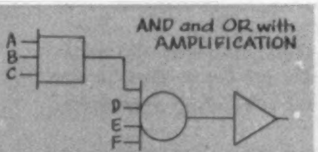
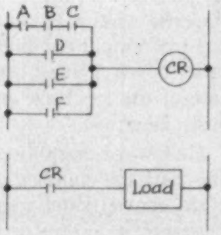
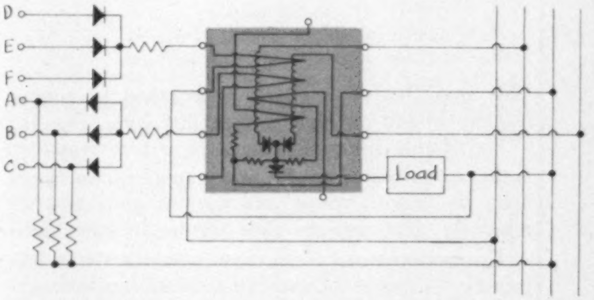
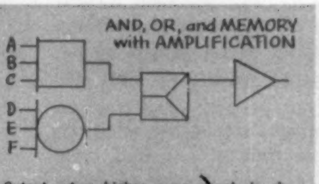
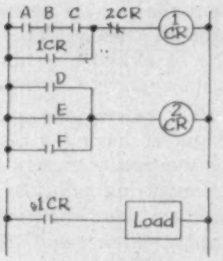
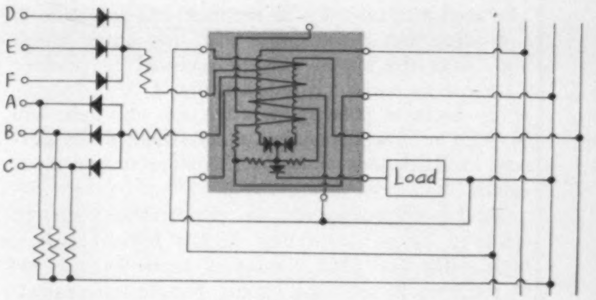
Function, Logic Symbol, and Description	Relay Circuit	Magnetic Amplifier Switching Circuit
AMPLIFICATION  The output reproduces the input but at a higher power level.	 	
AND with AMPLIFICATION  Output, at a higher power level, is obtained only when all inputs (A, B, C, and D) are present.	 	
OR with AMPLIFICATION  Output, at a higher power level, is obtained when any one or more of the inputs are present.	 	
NOT with AMPLIFICATION  Output, at a higher power level, is obtained only when no input is present. The output is not obtained when the input is present.	 	

addition to the direct switching of loads up to about 20 watts.

▸ Magnetic Amplifier Fundamentals

A magnetic amplifier may be defined as a device which utilizes the magnetic effect of an input signal to control a larger amount of power in a load circuit. For the purpose of this discussion the term magnetic amplifier will be limited to static devices utilizing saturable core reactors in conjunction with other circuit elements to achieve amplification or control of electrical signals.

A saturable reactor is an inductor utilizing the nonlinear magnetization curve of a saturable ferromagnetic core material. In its simplest form a reactor consists of a closed magnetic core linked by two windings. The gate winding, connected in series with the load and a source of ac power, constitutes a variable impedance. The effective impedance of

Function, Logic Symbol, and Description	Relay Circuit	Magnetic Amplifier Switching Circuit
NOR with AMPLIFICATION  Output, at a higher power level, is obtained only when none of the inputs are present. The output is not obtained when any one or more of the inputs are present.	 	
OFF RETURN MEMORY with AMPLIFICATION  Output, at a higher power level, is obtained as a result of input at A and persists when input at A is removed. Input at B turns output off, and it remains off until there is an input at A without an input at B. Interruption of power turns output off, and it remains off until there is an input at A.	 	
AND and OR with AMPLIFICATION  Output, at a higher power level, is obtained when A and B and C are simultaneously present or when D or E or F are present.	 	
AND, OR, and MEMORY with AMPLIFICATION  Output, at a higher power level, is obtained when inputs A and B and C are simultaneously present and persists even when any or all are removed. Input at D or E or F turns output off until there are simultaneous inputs at A and B and C without inputs at D or E or F.	 A B C 2CR 1CR 1CR D E F 2CR 1CR Load	

the gate winding can be varied by a current injected into a second winding, the control winding. Thus the load current and power to the load can be controlled.

With the balanced two-core construction shown in *Fig. 1a*, or with an equivalent arrangement using a standard three-legged laminated core, no net voltage of fundamental frequency is induced in the control winding. As a result, insulation breakdown problems, which might otherwise occur with control windings of very many turns, are minimized. Also, the control circuit is effectively decoupled from the power circuit.

When wound on a high permeability core, the saturable reactor is a constant current device which tends to produce an average ac load current directly proportional to the dc control current. This relationship can be expressed by the law of equal ampere turns, which states that the product of the load current and the gate turns is equal to the prod-

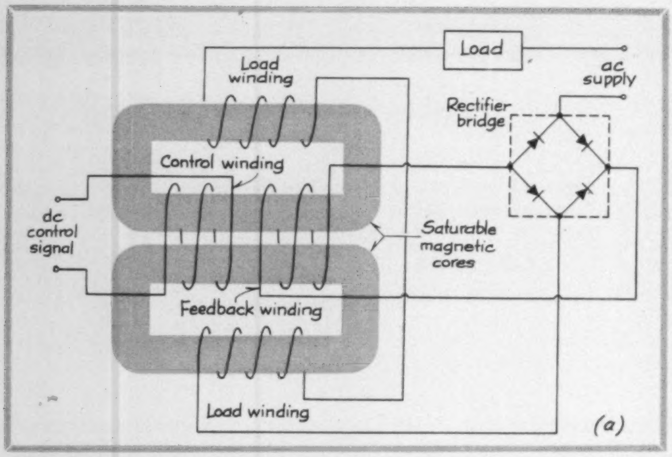
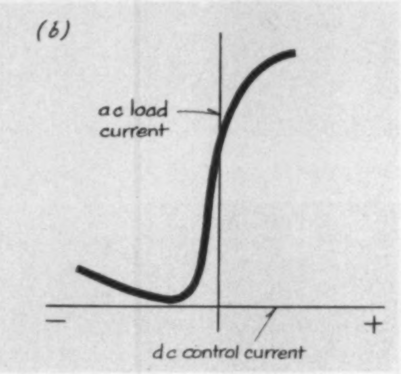


Fig. 2—When rectifiers and feedback windings are added, as in (*a*), the load current may be used to aid or oppose the magnetic effects of the control current. Such a feedback arrangement produces a transfer characteristic curve of ac load current vs. dc control current, shown in (*b*), which is typical of magnetic amplifiers.



uct of the control current and the number of control turns:

$$N_c I_c = N_g I_g$$

where

I_c = control winding current
I_g = gate (load) winding current
N_c = number of control winding turns
N_g = number of gate (load) winding turns

This characteristic is closely approached by simple reactors wound on high permeability cores, *Fig.* 1*b*.

The simple saturable reactor is a true amplifier usable in its basic form for many applications. However, its limited power and current gain and its relatively slow response time restrict its usefulness.

The performance of the saturable reactor is improved by means of positive current feedback arrangements which result in increased current gain. The load current may be rectified and fed back to a winding that is concentric with the control winding. Thus the signal current required to produce a given load current is reduced, *Fig*. 2. Also the amplifier becomes polarity sensitive, i.e., the gain will be high or low depending upon whether the current feedback aids or bucks the effect of the input signal.

Similar improvements in performance can be achieved by self-saturating circuits which produce high gains and high figures of merit by the use of rectifiers in the gate circuit. Simple self-saturating circuits which produce ac or dc outputs are shown in *Fig*. 3.

During the past several years magnetic amplifier circuits inherently capable of operation with time delays of one half to one cycle of the carrier supply have come into widespread use. These amplifiers consist of half-wave self-saturating elements so arranged that the output delivered to the load during the gating half cycle is determined by the level to which the flux in the core is preset during the preceding reset half cycle. By effectively decoupling the control and gating circuits, power gain is achieved with fast response, and control by either ac or dc signals may be used.

Circuits of this type, *Fig*. 4, have already proved to be very useful in numerous applications. Fast response and possible circuit simplicity are advantages of amplifiers of this class. However, the maximum power gains obtainable are lower than in the case of the feedback and self-saturating types previously described.

Half-wave amplifiers may be constructed with one half the number of core loops required for the more conventional circuits. For example, a phase-reversing ac output may be obtained with a single pair of toroidal cores. However, voltages of fundamental frequency are induced in the control circuits. As a result, precautions must be taken to prevent the flow of excessive currents caused by these induced voltages. This may be accomplished by the use of blocking rectifier arrangements or high impedance control circuits.

Net power gains per stage obtainable with an amplifier having a response time of one half cycle of the carrier supply are affected by the necessity of supplying sufficient energy from the control circuits to reset the core flux once per cycle of the supply. As a result, the average control power required is high.

The wave form of the gate current or load voltage of a saturable reactor or a self-saturating magnetic amplifier is nonsinusoidal except at the fully saturated condition. This distortion is most pronounced with sharply-saturating square-loop core materials and is inherent in saturable reactor operation. Prior to saturation the output current is essentially the magnetization current of the cores and therefore is small. When the core flux reaches saturation, the core inductance drops nearly to zero, and almost full supply voltage appears across the load for the rest of the half cycle.

At the time of firing, the output voltage rises sharply with a nearly vertical step. This sharply rising wave front is adjustable over practically the full 180-degree range by means of variations in the control signal input. In switching circuits where only the full on and full off conditions are of primary interest, this wave form characteristic is of secondary interest. However, this characteristic is particularly useful when the magnetic amplifier is used to provide a gating signal for *proportional* control of thyratron tubes, transistors operating in the switching mode, and silicon controlled rectifiers.

▶ Gain and Response Time

The speed of response which can be achieved by a magnetic amplifier is limited by the frequency of the power supply to the gate circuit. The minimum response time obtainable is in the order of 1 period of the power supply, and this performance can be attained only when operated at relatively low power gains. The power gain of a magnetic amplifier is defined as the change in load power divided by the change in control power required to produce it.

$$K = \frac{\text{Load power change}}{\text{Signal power change}}$$

$$K = \frac{(\Delta I_g)^2 R_2 k_f^2}{(\Delta I_c)^2 (R_f + R_c)}$$

where

ΔI_c = control current change
ΔI_g = load current change
K = power gain
k_f = form factor of load current. (varies from 1.1 at full output to about 1.5 at low output values)
R_c = control winding resistance
R_f = external forcing resistance in series with control winding
R_2 = load resistance

The output response of a magnetic amplifier to a change in control current is practically instantaneous. Exceptions to this statement must be taken in the case of the parallel-connected simple saturable reactor or the self-saturating ac doubler circuit which provide a path for a circulation of current through the gate windings. For such circuits a lag several times the period of the supply voltage may be introduced between the application of signal current and the response of the load current.

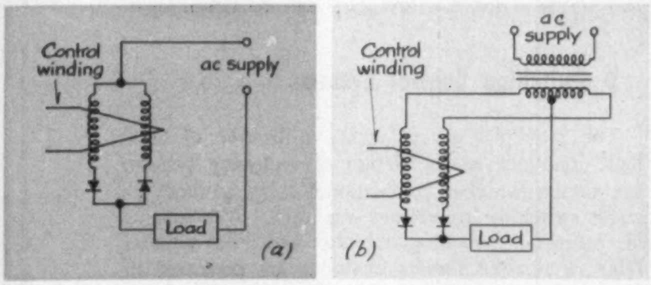


Fig. 3—Schematic diagrams indicate two basic types of self-saturating circuits. Performance of such circuits is similar to that of circuits using feedback windings. In (a) is a doubler circuit for ac output; while (b) shows a full-wave circuit for dc output.

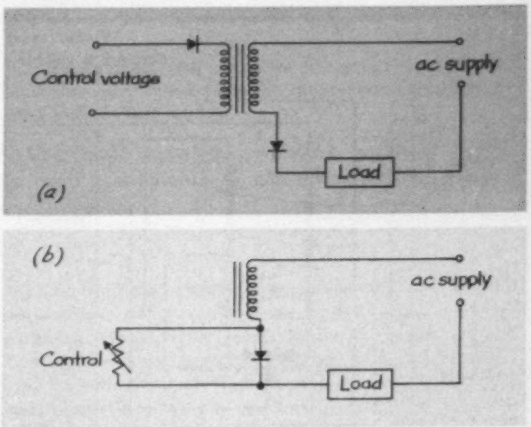


Fig. 4—Reset circuits represent another important variety of magnetic amplifier arrangement. They can provide fast response and circuit simplicity, but maximum power gains are lower than for feedback and self-saturating types. Shown by (a) is a basic half-wave amplifier of the flux resetting type. Control by either ac or dc signals may be used. Circuit in (b) illustrates a half-wave magnetic amplifier with variable resistance control.

Because the control winding is an inductive element, there is a time lag between the application of a voltage to the control circuit and the flow of control current. The time constant is proportional to the effective control winding inductance divided by the total resistance of the control circuit.

$$T = \frac{L_c}{R_f + R_c}$$

where

L_c = control winding inductance
R_c = control winding resistance
R_f = external forcing resistance in series with control winding
T = the time constant

Increasing the resistance in the control circuit proportionately reduces the time constant. This applies until the time constant approaches the period of the supply voltage. Since an increase in the control circuit resistance reduces the time constant, it is possible to improve amplifier response within limits by increasing the resistance of the forcing resistor. Although this sacrifices some power gain, the ratio of power gain to time constant remains fixed.

In a given reactor, power gain is proportional to ac supply frequency. The time constant is expressed, therefore, in cycles of supply voltage rather than in seconds. This leads to a widely used figure of merit for magnetic amplifiers; the ratio of

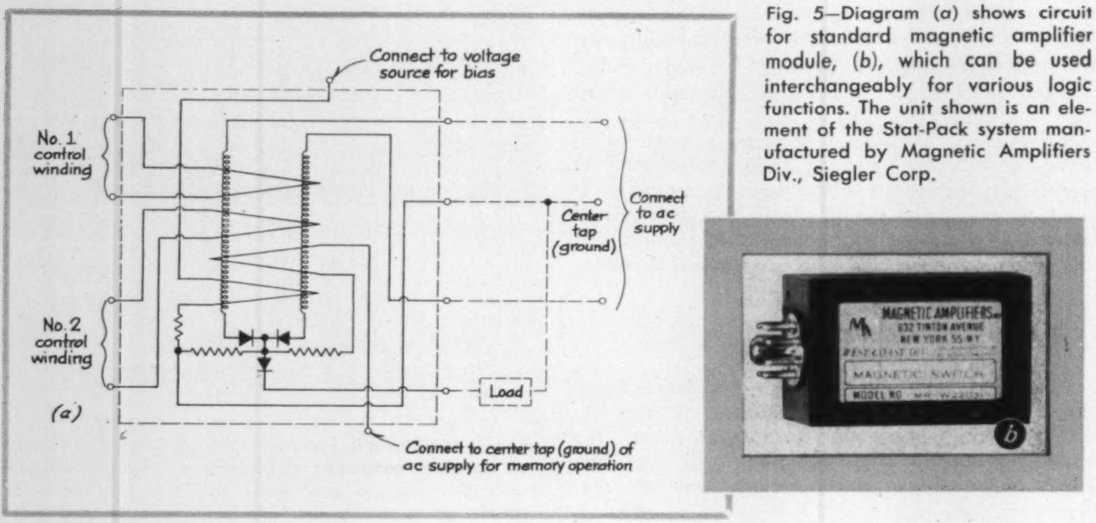


Fig. 5—Diagram (*a*) shows circuit for standard magnetic amplifier module, (*b*), which can be used interchangeably for various logic functions. The unit shown is an element of the Stat-Pack system manufactured by Magnetic Amplifiers Div., Siegler Corp.

power gain to time constant measured in cycles. For a simple series saturable reactor this ratio is about four. For a self-saturating magnetic amplifier utilizing high permeability core material the figure is in the order of 1000.

From these relationships it is apparent that, where fast response is a factor, operation of magnetic amplifiers with a high frequency power supply should be considered. Substantial savings in size and cost of magnetic components can also be achieved by high frequency operation. Supply frequency up to a few kilocycles per second are feasible for operation of power control magnetic amplifiers.

The magnetic amplifier will operate satisfactorily with nonsinusoidal supply voltages. For example, the square wave voltages readily generated by semiconductor power converters are well suited for use with magnetic amplifier circuits.

The feasibility of operating magnetic switches at a high carrier frequency is dependent upon the availability of an economical and reliable ac power source. Our standard power converter consists of a rectifier section and an inverter section. The rectifier section converts the normal ac supply voltage to low voltage dc. The inverter section utilizes gated transistor circuitry to convert the dc to a square wave output at 2000 cps. This arrangement makes it possible to operate the system from a direct current supply or to utilize a standby battery floating across the output of the rectifier section to insure uninterrupted operation of critical systems in case of failure of the main power supply.

▶ A Basic Module

The basic module used in the static switching system we developed is a self-saturating element producing a full-wave direct current output. A schematic diagram of this unit is shown in *Fig.* 5. This arrangement is generally similar to the center tap circuit shown in *Fig.* 3*b*.

Two signal input windings plus a bias input and a feedback input are provided in the standard design. In order to achieve fast response time and small size, the amplifier units are designed to operate at a supply frequency of 2000 cps. By operating with the high frequency carrier, it is feasible to utilize identical units for logic functions requiring very low output power and also as a medium power output unit to control loads up to approximately 20 watts.

This one basic module is capable of performing all the principal logic functions in addition to switching and power amplification. As a result, complex switching systems may be synthesized with a single component type.

The basic module is designed so that a current change of 1 milliampere into any one of its signal input windings is sufficient to cause a change from the *On* or full output condition to the *Off* or minimum output condition. By connecting a positive feedback signal from the output into the feedback winding the unit is caused to trigger so that only two stable states, *On* and *Off*, can be maintained.

▶ Switching Control Systems

The principles governing the utilization of basic logic functions in the design of switching systems are similar whether conventional relay methods or static switching techniques are used. Comparisons of magnetic switching circuits and conventional relay circuits for similar functions are presented in TABLE 1. A competent designer accustomed to electromechanical relay circuits should have little difficulty in employing static switching devices. In fact, magnetic amplifier components, providing multiple, isolated signal input circuits, will often greatly simplify the circuit design problem.

The following are significant differences between the static magnetic switch and a conventional electromechanical relay.

1. The magnetic switch will have a finite output in the *Off* position in contrast with the truly zero output which an open relay contact provides. A ratio of *On* to *Off* output voltage of 25 to 1 is typical of what is normally provided by the magnetic switch.

2. The signal level to which the magnetic switch will respond is considerably lower than that usable with conventional relays.

3. A relay may have a number of contacts electrically isolated from each other, where the static switch normally provides a single output.

Our basic magnetic switching amplifier module is readily adaptable to circuits where response to

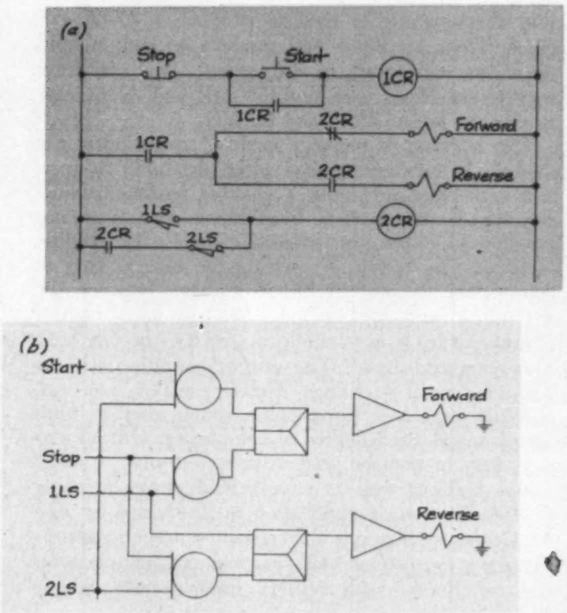
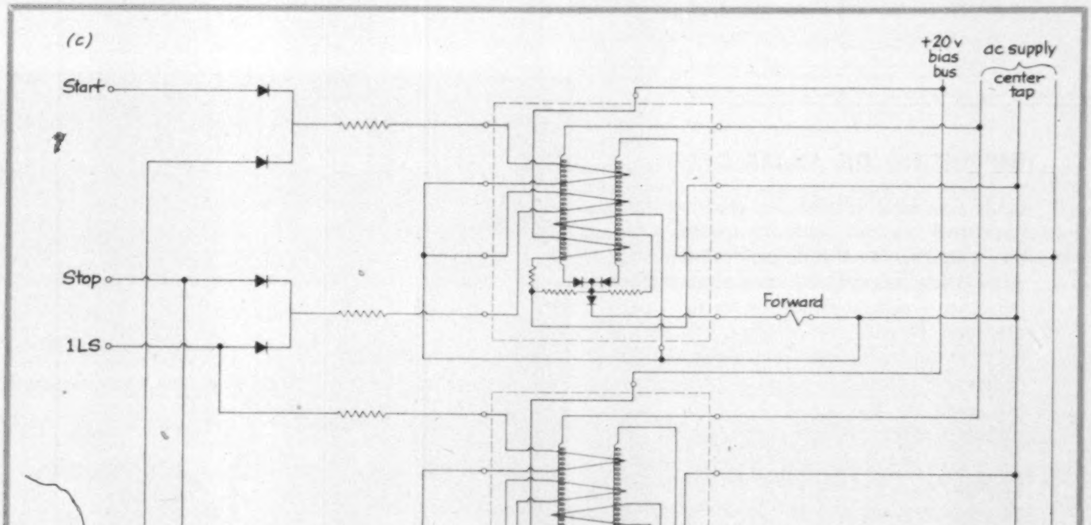


Fig. 6—Reversing table drive illustrates comparable applications of a relay circuit and a static magnetic switching circuit. The relay circuit is shown in (*a*). Pushing the *Start* button energizes 1*CR*, and it seals itself in with a set of contacts around the *Start* button, 1*CR* also energizes the *Forward* solenoid so that the table moves forward. When 1*LS* is closed at the end of table advance, it energizes 2*CR* which seals itself in with a set of contacts around 1*LS*. 2CR also de-energizes the *Forward* solenoid and energizes the *Reverse* solenoid. When the table is fully retracted, 2*LS* is opened and 2*CR* is de-energized. The *Reverse* solenoid is therefore de-energized, the *Forward* solenoid energized, and the cycle repeats. A logic diagram to perform a similar cycle is shown in (*b*). The magnetic switching circuit in (c) uses six blocking rectifiers and two standard magnetic amplifier modules for the functions indicated in the logic diagram. A momentary signal on the *Start* line in the absence of a *Stop* signal will energize the *Forward* solenoid, and the memory function of the *Forward* switching module will maintain forward motion. At the end of the advance a signal will appear from 1*LS*. The *Forward* solenoid will be de-energized, the *Reverse* solenoid energized, and the table will retract. Reverse motion will be maintained by the memory function of the *Reverse* switching module. At the fully back position a signal from 2*LS* will appear and the cycle will repeat.



multiple input signals is required. Resistive summing of currents may be used. However, when the number of input signals increases above about three, this method becomes critical with respect to values of the resistive networks and regulation of signal and bias sources. A more reliable method involves the use of diode logic in conjunction with the magnetic switching amplifier.

This method can be illustrated by a multiple input *AND* circuit. The *AND* circuit is a basic logic function which will provide an output only when input signals are simultaneously applied to all of its inputs. In the absence of input signals a module may be maintained in its *Off* position by connecting a control winding to a source of current so that approximately 1 milliampere in the cutoff direction flows through the winding and through a series diode.

If a voltage exceeding the signal supply voltage is connected to the cathode of the series diode, the diode is blocked, the *Off* control current is reduced to zero, and the magnetic switch goes to the *On* condition.

Any number of diodes may be paralleled to provide a multiple input *AND* function. This arrangement provides a very reliable circuit even with a large number of inputs. The level of the signal voltage is not critical as long as it exceeds the control voltage source.

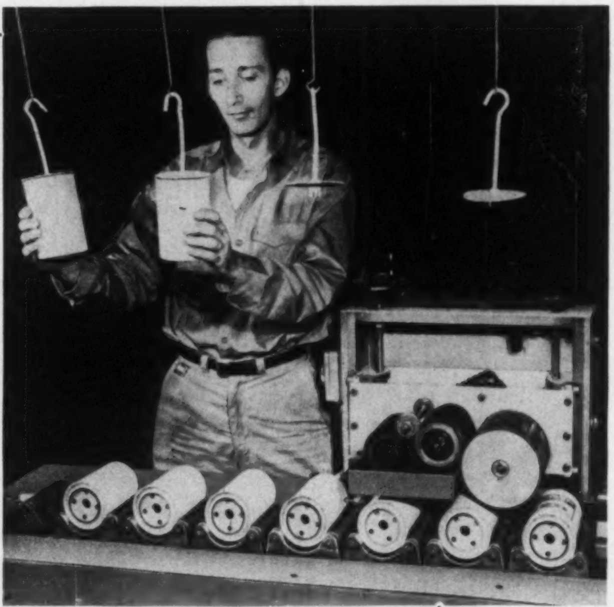
The *OR* circuit is a basic function which will provide an output when any of a number of input signals is present. The basic method of using *OR* logic is to bias the module *Off* so that there is no output in the absence of input. A positive input signal applied to any one of the *OR* input terminals will then drive approximately 1 milliampere into the control winding in the direction which causes the module to go on. The current is limited by a resistor appropriate for the level of control signal. For a 28v control level, the resistor value would be approximately 28k. Any number of diodes may be paralleled to provide a multiple input *OR* function. The Stat-Pak module normally will produce an output in the absence of signal or bias; this characteristic is used to produce a *NOT* element. Thus, an input will produce no output, and no input will result in an output. This condition may be combined with multiple *OR* and *AND* logic to give the logical *NOR* and *NAND*.

The latching or memory mode of operation of the module is very useful and often desirable in control systems. Connecting a positive feedback winding makes the module bistable so that it is not possible to effect proportional control—the module is either *On* or *Off*. By setting the bias so that at zero signal the unit is biased midway between the ascending and descending sides of the transfer characteristic, it is possible to turn *On* or *Off* with a momentary signal. The output condition will be sustained until a change-of-state signal is received.

With these basic functions a system may be built up of any desired degree of complexity. Output signals may in turn be used to provide inputs to additional logic as well as supply load power to other devices. One such application is illustrated by *Fig.* 6. Other applications throughout automatic manufacturing operations will become commonplace as the benefits of such systems become more widely appreciated.

IMPRINTING OIL FILTER CANS

CAN COMPONENTS for oil filters are imprinted on two sides by special automatic marker at Purolator Products Inc. After being painted, the cans are removed from an overhead conveyor by the operator and placed in individual cradles on the printer conveyor line. The cradles constantly rotate the cans, and the printing head on the marking machine also rotates to apply different imprints on two sides of the can. Industrial Marking Equipment Co. Inc. developed this machine to replace the previous method of applying decals by hand. Hand marking had been found too slow, subject to too much variation on location, and resulted in a high scrap rate due to a large percentage of decal damage.



CYCLING FILTRATION UNITS PROVIDE HIGH-POLISH WATER

WHEN the industrial applications of water filters are considered, it is apparent that such filters are properly classed as basic production equipment. Of the variety of filter types, those using diatomaceous earth as a precoat over a porous surface are of particular importance because of their ability to provide "high polish" industrial water (free of microscopic particles and organisms).

Operation of this type of filter is complicated by the need to periodically remove, or backwash, the contaminated precoat, or filter-aid, and replace it with a fresh precoat. The time between backwashings can be lengthened by continuously introducing fresh filter-aid throughout a filtration cycle—typically up to the point that the increasing thickness of filter material and foreign matter cause a pressure drop that might interfere with operations. Resulting in such benefits as lower upkeep costs and freedom as to where filters can be located, operation of diatomaceous earth filters can be made automatic. The filter installation at Liebmann Breweries Inc., Brooklyn, N. Y., illustrates the techniques used to obtain automatic operations. The filters were manufactured by R. P. Adams Co. Inc.

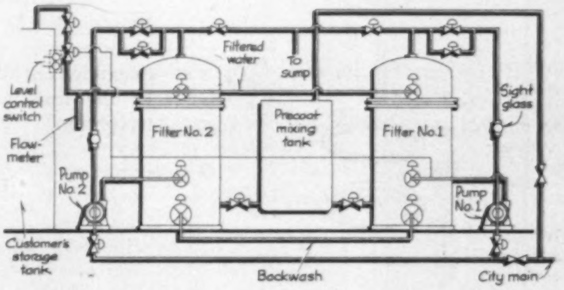
Requiring clear water for their bottle-washing and process operations, the brewery found it expedient to filter water from the city main. Two diatomaceous earth filters with automatically timed filter cycles were installed. The units are connected in parallel between the city water main and a 30,000 gallon storage tank. Also connected in the installation is a storage tank that contains the precoat in slurry form. Alternating on a time basis, one of the two filters is on-stream at all times. Following a backwashing cycle, the off-stream filter is held on standby, ready for precoating.

The control technique is relatively straightforward and completely automatic in operation. Either a pressure differential switch or timer may be used to control the length of time that a filter remains on-stream and to actuate a master timer. The illustrated brewery installation uses an auxiliary timer for this purpose. With either approach, as switchover becomes imminent, the master timer is actuated to control the sequence of events that must precede the placing of the standby filter on-stream. The proper quantity of precoat slurry is allowed to flow from the slurry storage tank into the raw water side of the standby filter. Following this, the filter is automatically filled with raw water, and valves are automatically actuated to connect the unit into an isolated recirculating system containing a pump. After a timed recirculating cycle, the precoat is properly distributed over the porous filter element, and the unit is ready for use.

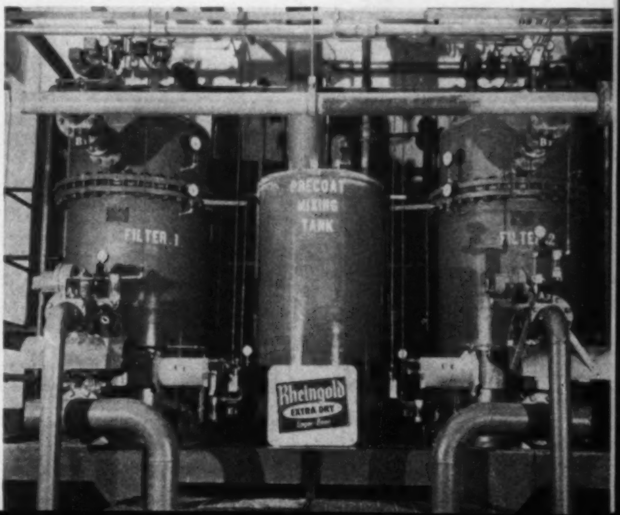
Under master timer control, the fresh filter is placed on-stream (beginning its cycle of operation) and the spent filter is taken off-stream. Still controlled by the master timer, valves are actuated to first drain the spent filter, then close the outlet side of the filter. Water is forced by pump pressure into the filter, trapping and compressing the air in the filter shell. In effect, the filter becomes a hydraulic accumulator.

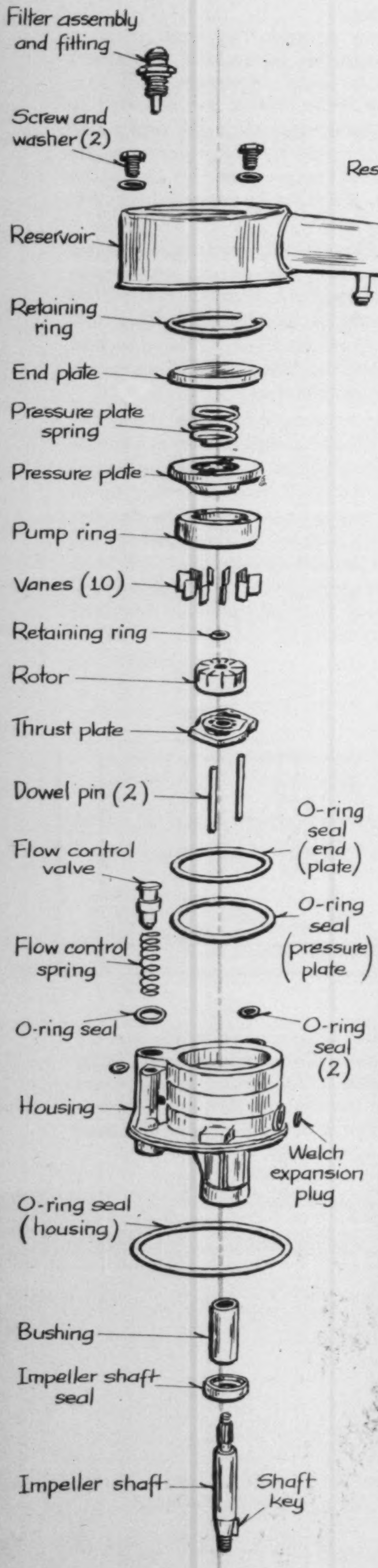
When the large backwash valve on the raw water side of the filter is opened, the accumulator action causes high velocity flow back through the porous filter element, effectively backwashing the filter cake and foreign material from the filter. After a second such backwashing cycle, the filter is placed on standby, and the master timer times out.

In addition to these automatic features, the brewery control system includes a flow meter to provide nearly constant maximum filter output regardless of pressure drop across the filter. A high level control on the filtered water storage tank can place the on-stream filter into recirculation if the need arises. Provisions are also included to signal a low-level condition in the slurry storage tank, the maintaining of slurry being the only manual operation involved in the filtering operation.



To obtain requisite quality of process water for brewery operations, two automatic diatomaceous earth filters are used. Under control of automatic timers, filters are alternately placed on-stream. Between filtration cycles, the off-stream filter is automatically backwashed to remove filter cake and foreign matter.




Filter assembly and fitting
Screw and washer (2)
Reservoir cap
Reservoir
Retaining ring
End plate
Pressure plate spring
Pressure plate
Pump ring
Vanes (10)
Retaining ring
Rotor
Thrust plate
Dowel pin (2)
O-ring seal (end plate)
Flow control valve
O-ring seal (pressure plate)
Flow control spring
O-ring seal
O-ring seal (2)
Housing
Welch expansion plug
O-ring seal (housing)
Bushing
Impeller shaft seal
Impeller shaft
Shaft key

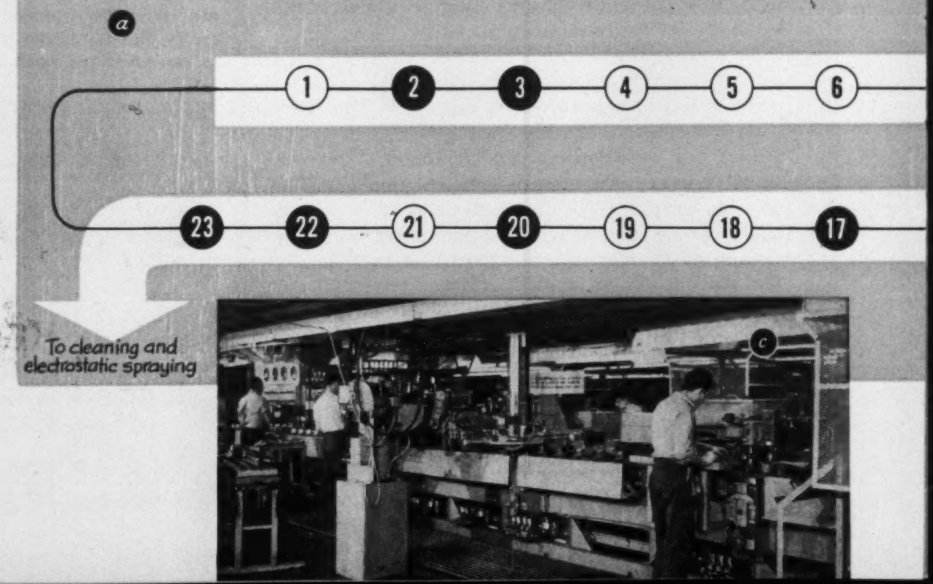
PUMP ASSEMBLY MACHINE

COMBINES MANUAL AND AUTOMATIC STATIONS

By ROBERT H. MILLER, Field Engineer, Swanson-Erie Corp., Erie, Pa.

ECONOMICAL assembling and testing of some products calls for a combination of manual, semiautomatic, and automatic operations. Where such is the case, optimum results may often be obtained by setting up a production line in which all three types of operations can be performed in the proper sequence and at a machine-controlled rate. Operators are then stationed where required in the line, and automatic operations proceed without human intervention.

Fig. 1—Schematic plan view of multistation pump assembly machine, *(a)*, indicates work performed at each station. In *(b)*, operator is shown assembling "O" ring seals to pump housings at Station 4. Same operator inserts dowel pins and impeller shafts in housings at Stations 5 and 6, left. View of opposite side of machine, *(c)*, illustrates variety of manual, semiautomatic, and automatic operations performed.


a
1
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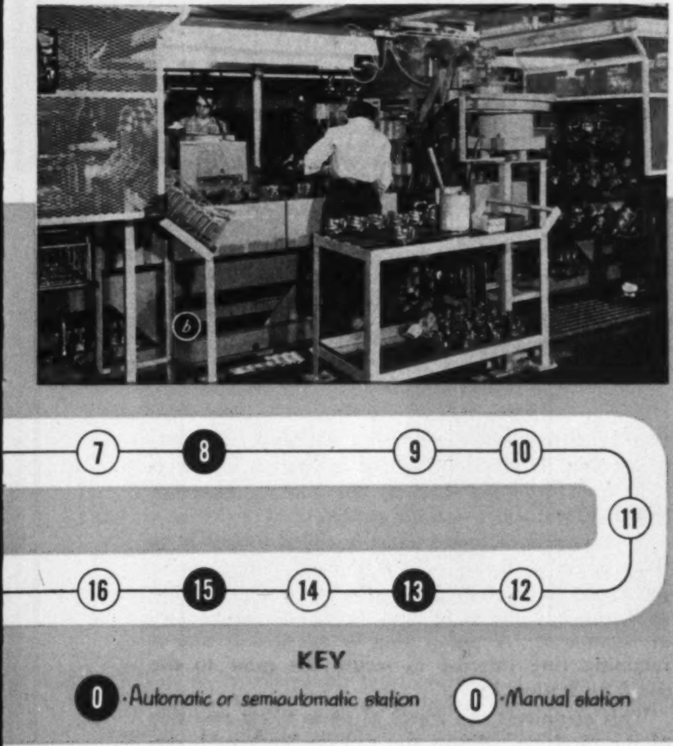
To cleaning and electrostatic spraying
c

Where certain operations in a production sequence are difficult to achieve automatically, a line which includes manual as well as automatic workstations should be considered. Such an arrangement, described by the author, allows over-all control of a line and transferring of parts between workstations to be made automatic. Also, full advantage can be taken of the savings inherent in performing operations automatically where possible.

A line for assembling and testing automotive power steering gear pumps, *Fig.* 1, is a case in point. Built around a 40-foot long, in-line indexing machine chassis supplied by Swanson-Erie Corp., the line includes 23 workstations at which various assembly and testing operations are performed. Products coming off the line are completely assembled and tested hydraulic pumps which are ready to be painted and packaged for shipment. Production rate of the line is 500 pumps per hour.

Several factors dictated the choice of indexing chassis that was used in this application. For example, a 40-foot long unit was selected largely because of the locations of existing overhead parts conveyors—changing the conveyor layout would have cost more than lengthening the chassis. The relatively large size of some of the parts, and the large number of workstations needed, made the use of an in-line machine preferable to a rotary indexing unit. Also, space required for manual operations could be provided conveniently on a standard in-line unit.

Pumps are assembled on a series of individual pallets which contain pins, bushings, and studs to support and locate the cast iron pump housings. The pallets are attached to an endless roller chain that travels around the outside of the indexing chassis. A main camshaft in the base of the machine provides the necessary intermittent motion of the chain to index 120 pallets through 9-inch strokes



Sequence of Operations

Station

1. Assemble O-ring seal and Welch plug. Place housings on pallets.
2. Press-in steel balls.
3. Assemble impeller shaft seal and apply lubricant.
4. Assemble (2) O-ring seals.
5. Assemble (2) dowel pins.
6. Place impeller shaft in bushing.
7. Assemble thrust plate.
8. Assemble end and pressure plate O-ring seals.
9. Assemble pump rotor.
10. Assemble pump ring and shaft retaining ring.
11. Assemble (10) vanes.
12. Assemble pressure plate.
13. Press pressure plate in position.
14. Assemble pressure plate spring and end plate.
15. Depress end plate and assemble retaining ring.
16. Insert flow control spring and valve.
17. Grease and assemble reservoir.
18. Insert filter assembly and fitting.
19. Assemble (2) screws and washers,
20. Tighten screws and fitting.
21. Assemble and press-in shaft key.
22. Leak test.
23. Functional test.

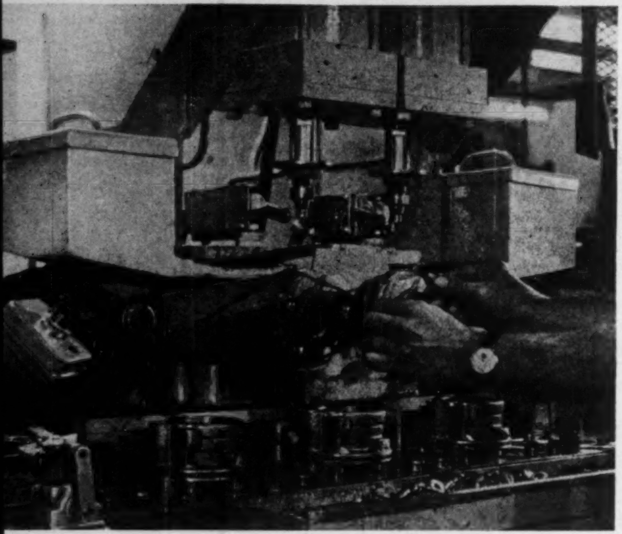


Fig. 2—Close-up of Station 1 shows the fixture used to support pump housings during assembly of O-ring seals and Welch-type expansion plugs. Two rams, center, descend to press the plugs in the housings. After these operations are completed, housings are placed on pallets of indexing machine, foreground.

along machined ways. At workstations where accurate positioning is required, the pallets are located by air-actuated shot pins. Once they are placed in the pallets, the workpieces can be indexed through all operations without the need to move or reposition them.

The machine cycle is broken down into a 3.7 second dwell period (during which time the manual and automatic operations are performed) and a 3.5 second index period. The total cycle time of 7.2 seconds establishes the maximum production rate of the machine at 500 assemblies per hour.

▶ Operational Sequence

A production cycle begins when an operator at Station 1 selects a pair of pump housings and places them in a stationary assembly fixture, *Fig.* 2. With the parts in the fixture, the operator assembles an O-ring seal and a Welch-type expansion plug to each housing. A pair of rams above the fixture is then actuated to set the plugs in the housings. After these operations, the housings are placed, bushing-end down, on the pallets.

At Station 2, *Fig.* 3, two adjacent workheads operate automatically to press a steel ball into each of a pair of holes in the housing. The balls are fed in tubes leading from rotary hoppers, and are forced into the holes by hydraulically operated presses. Purpose of these assembly operations is to block off the external openings of holes drilled to create internal oil passages. A lock-out limit switch between Stations 1 and 2 prevents the presses from operating if there is no pump housing on a pallet or if the part is improperly seated.

Another automatic assembly operation is performed at Station 3. At this workstation, *Fig.* 4, an impeller shaft seal is fed on tracks from a vibratory feeder to an assembly device below the pallet. The seal is then assembled to the end of the housing with the housing held down by an overhead ram. During this operation, grease is applied to the outside and inside diameters of the seal to facilitate assembly and to aid in assembling an impeller shaft at a later workstation. Oil is also applied to the impeller shaft bushing to lubricate this component.

Two internal "O" rings are next assembled at Station 4. At Station 5 the same operator drops two dowel pins into the housing assembly. The impeller shaft is manually placed at Station 6, and is held from dropping through the housing assembly by a rail located beneath the pallets.

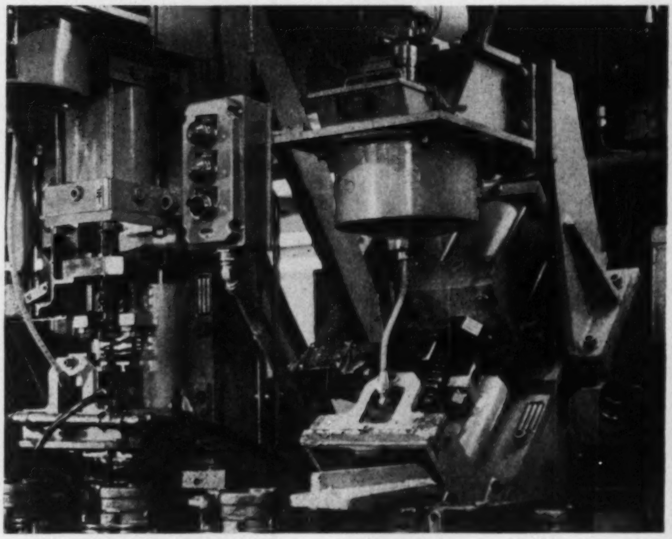


Fig. 3—Two automatic workheads at Station 2 assemble steel balls in openings of oil holes drilled in the housings. Balls, fed in tubes from rotary hoppers, are forced into the holes by hydraulic rams. An electrical interlock between Stations 1 and 2 prevents operation of the rams if a pump housing is missing or improperly seated on a pallet.

At Station 7, a thrust plate is added manually to the assembly. Two O-rings for end and pressure plates are positioned automatically in the housing at Station 8, and a pump rotor is assembled manually at Station 9. A pump ring is assembled, and a retaining ring inserted to secure the rotor to the shaft, at Station 10.

This completes the travel of parts along one side of the machine. Across the end, at Station 11, operators insert ten vanes in the rotor slots of each assembly. Two operators are assigned to this workstation in order to keep up with the line. After the vanes have been assembled, the impeller shaft is allowed to drop to its normal position in the assembly. This occurs as the pallets are indexed past the end of the rail supporting the impeller shafts.

As the workpieces start the return trip on the opposite side of the machine, a pressure plate is manually added to the assembly at Station 12. The pressure plate is automatically pressed into position at Station 13, *Fig.* 5, when a limit switch senses the presence of an assembly.

An operator at Station 14 places a pressure plate spring and an end plate in the assembly. At Station 15 the end plate is depressed against the spring and a retaining ring is fed and assembled automatically.

At Station 16, an operator drops a spring and a preassembled flow control valve into position in the pump housing. He then adds an O-ring to the top of the valve chamber.

An oil reservoir is greased and assembled automatically at Station 17, *Fig.* 6. At this station, an operator loads two reservoirs on special fixtures that apply grease automatically to the inner edges of the units. With a pump housing on a pallet opposite each fixture, two workheads are actuated. Each workhead lifts a reservoir from a fixture and presses it on a housing. A rotation of 30 degrees is required as the piece is lowered to permit insertion of an oil tube which projects at a compound angle from the reservoir.

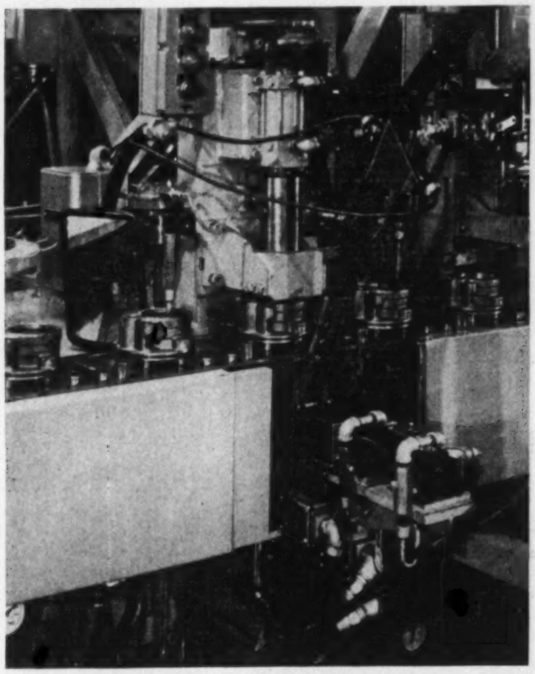


Fig. 4—Impeller shaft seals are fed on tracks from a vibratory feeder to a point below the pallets at Station 3. There, a mechanism automatically inserts a seal in the end of each housing as the workpiece is held down by a ram. A bushing in the housing, and the seal itself, are lubricated automatically during this operation.

At Station 18, a filter assembly and a fitting are inserted through a hole in the reservoir into the chamber containing the flow control valve and spring that were assembled previously. The threads on the fitting are started by hand. Two cap screws with washers are assembled at Station 19, and the screws and fitting are tightened automatically at Station 20, *Fig.* 7.

The nearly completed assembly is taken off its pallet at Station 21 and a shaft key is assembled to the impeller shaft. The key is pressed in place on a floor press located near the station. After this operation, the pump is returned to its pallet and progresses to the first of a series of leak and performance tests.

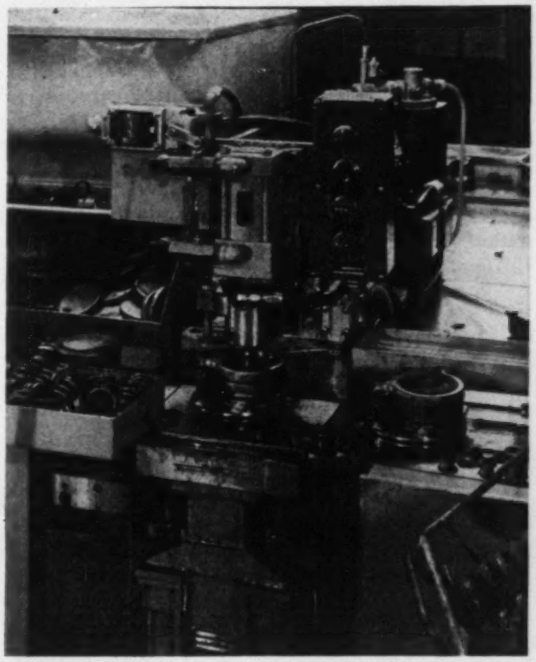


Fig. 5—Pressure plate, placed in housing at Station 12, is automatically pressed into position at Station 13 by ram, shown. Shot pins below table enter sleeves in pallets to locate the parts during pressing operation. Parts then index to left where pressure plate spring and end plate are added.

At Station 22, the completed assembly is removed from its pallet and placed in a testing device, *Fig.* 8. After a pump has been loaded in a fixture, pneumatically actuated plugs automatically block openings in the housing. The machine then applies air at 35 psi pressure to the inner pump chamber to check for leaks. If the pressure has not dropped below a specified limit within 4 or 5 seconds, the fixture unlocks automatically and the operator returns the unit to its pallet. If an assembly has leaked, the fixture must be unlocked by hand and the defective unit placed on a rack for reworking.

Because of the time required for leak testing, the machine is equipped with four test stations. Each station includes a set of lamps that signal the status of a test. For example, lamps are provided to show that pressure is being applied; that a test has been completed successfully; or that a reject has been found. Dial pressure gages are also provided to indicate the test condition at each station.

After leak testing, the assemblies are moved to Station 23 where they undergo a complete functional test. Here, each pump is placed on a test stand and hydraulic oil is fed as in an actual installation. For example, the pump is first driven at 450 rpm, corresponding to operating speed when an automobile engine is idling. Speed is then increased to 1500 rpm to simulate a driving condition. In these tests, both flow and pressure are checked. In a final test, the flow is blocked completely at 1500 rpm to determine if the relief valve is functioning properly.

High and low ranges for pressure and flow have been established for each of the two testing speeds. If the pump fails to perform to specifications in any test category, the operator is signaled automatically. As another phase of functional checking, each test station is equipped with a noise amplifier. If the operator senses any objectional noise or whine during testing, he rejects the pump.

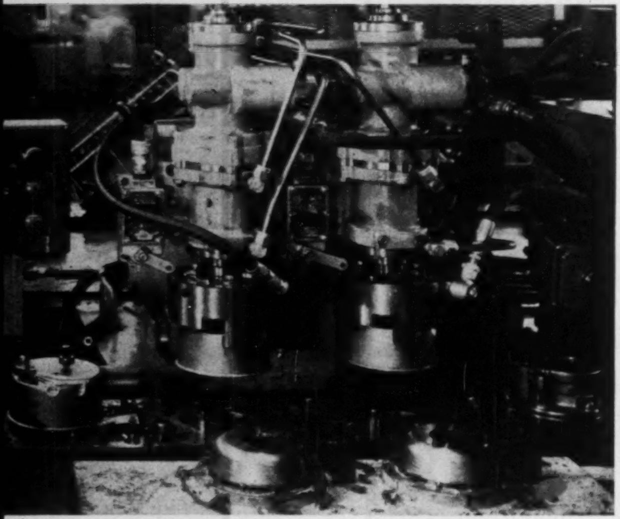


Fig. 6—Close-up of Station 17 shows tooling for loading and assembling oil reservoirs to pump housings. Reservoirs are placed on the two plugs, foreground, where grease is applied automatically to inner surfaces. Workheads then pick up the reservoirs, orient them, and lower them onto housings on pallets.

As each unit passes the final performance test, it is placed on a hook and transported by overhead conveyor to a cleaning unit and then to an electrostatic spray booth. After a suitable drying period, the unit is packaged for shipment.

Maintaining a continuous flow of components to the various workstations is an important function. Most of the large items—housings, impeller shafts, pressure plates, etc.—are delivered by a powered and free overhead conveyor system. As such parts are required at a workstation, an operator at the location presses a pushbutton. This starts an automatic cycle in which an empty parts rack is lifted out of the way and a loaded one is delivered in its place. Small parts such as O-rings, vanes, and screws are delivered to the workstations by floor cart. To minimize contamination of parts and completed pump assemblies, the room in which the machine is installed is kept slightly pressurized. This prevents migration of airborne dust and dirt into the room from other areas.

▸ Troubleshooting Aids

Interlocks at each workstation are designed to prevent damage to the machine or injury to operators. If a malfunction occurs at any station, the entire machine is stopped automatically.

To permit fast, accurate locating of breakdowns, the machine is equipped with a console control panel containing a set of signal lamps for each station. Beginning with indexing, the lamps flash on and off to indicate the start, duration, and completion of operations at each work location. If a work

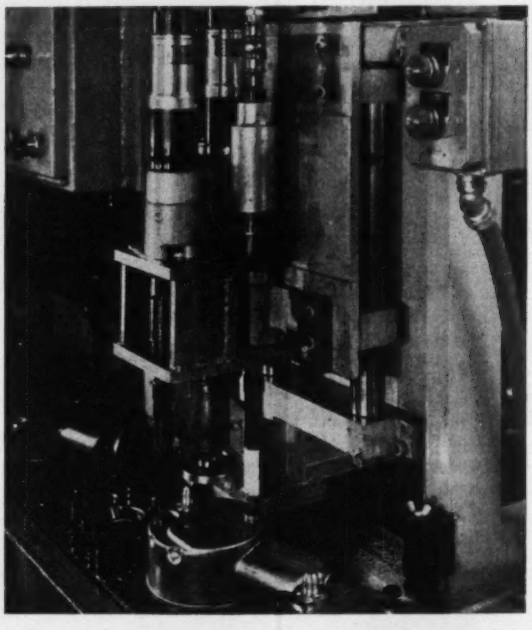
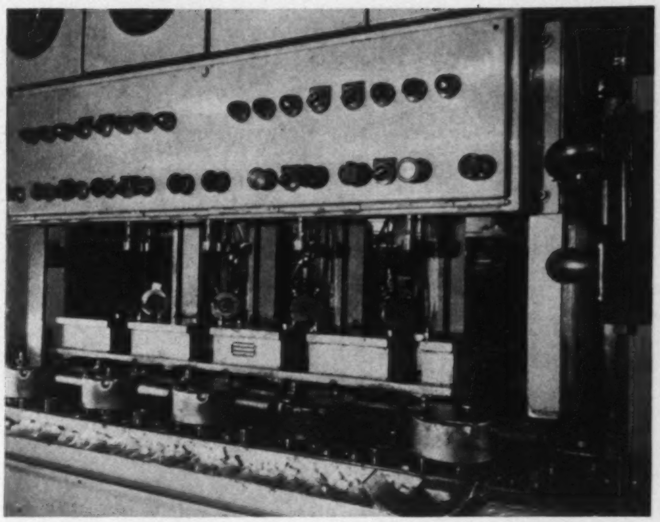


Fig. 7—At Station 20, two cap screws and a fitting are automatically run down and tightened as each pump is indexed into position. Plunger steadies each reservoir during this operation.

Fig. 8—Leak tester at Station 22 has four stands on which pumps are mounted. When a pump has been removed from a pallet and clamped in a stand, plugs automatically block openings in the housing. Air at 35 psi is then admitted to inner pump chamber. Pumps are accepted or rejected on basis of internal pressure after a test period of 4 or 5 seconds. Signal lamps indicate progress of tests and *Pass* or *Fail* status of pumps.



sequence is not completed at any station, a red light signals the fact so that a repairman can quickly pinpoint the trouble area.

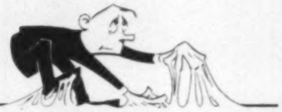
An electrical test board is also provided to facilitate locating of control circuit failures. The test board contains a functional diagram, drawn on a plastic sheet, that duplicates the electrical circuit of the machine. Wiring behind the sheet connects with coresponding key points in the machine control circuit.

To locate an electrical fault, a repairman inserts a probe through holes in the plastic sheet. This causes contact between the probe and the wiring behind the sheet. Since faults in the machine control circuit will also appear at the wiring in the test board, the repairman can quickly check out the system from the board. When a fault is located with the probe, an appropriate light comes on to identify the part of the circuit requiring attention.

▶ Standard Machine Chassis

The pump manufacturer has made full use of the advantages inherent in a standard indexing chassis—including an initial cost estimated at 50 per cent of that for a special unit with equivalent work transfer and tool mounting provisions. In addition, maintenance costs are relatively low because of the availability of off-the-shelf replacement parts and accessibility of the chassis components for adjustment and lubrication.

With installation of the assembly machine, the user has increased production by approximately 43 per cent and improved product quality. Similar gains may be available through adoption of these techniques in other fields where products are assembled and tested by a combination of manual and automatic operations.



are you stuck?

Since its inception Automation has helped increasingly in the solution of hundreds of widely diversified practical problems in making manufacturing operations more automatic. Regardless of the character of the operation or system being developed, somewhere in industry a similar problem has been solved and, very often, equipment is available from reliable builders or suitable techniques are known to specialists.

Development can be simplified, engineering costs reduced, and reliability guaranteed with tried and proved equipment and devices available today for achieving successful automation. Whether the problem is simple or complex, practical or technical, if you have not as yet seen the answer to your need in the pages of Automation the Editors will be pleased to make special effort to help find the right answer. The vast reservoir of industrial know-how is yours for the asking. Take advantage of this reader service. Write to: The Editor, Automation, Penton Bldg., Cleveland 13, Ohio.

PNEUMATIC-HYDRAULIC POSITIONING SYSTEM

TRANSLATES TAPE COMMANDS INTO TABLE MOVEMENTS

A UNIQUE pneumatic-hydraulic system requires no electrical components in translating punched tape commands into precise positioning of a machine member. Developed by Moog Servocontrols Inc., the system has been applied to position the table on a turret drill (See AUTOMATION, Oct., 1960, p. 10). The sketch indicates elements of the system required to position the worktable along one of its axes of motion. Commands describing a desired position are punched in the tape in binary coded decimal form. Four successive lines across the tape represent inches, tenths, hundredths, and thousandths of inches. Four possible hole locations on each line represent 1, 2, 4, or 8 units of the dimension called for on that line.

A pneumatic circuit is provided for each of the 16 possible hole locations. Each of these pneumatic circuits positions an independent plate element in one of two special hydraulic 8-level selector valves. Each plate can move to two positions—one when there is a hole punched in its command location on the tape, the other when there is not a hole in the tape.

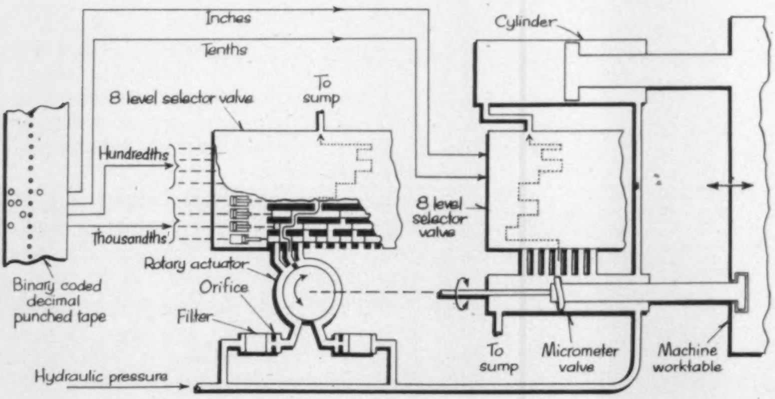
Positioning of the eight plates representing hundredths and thousandths of an inch determine which one of the 100 openings in a rotary actuator is open to the sump. Positioning of the eight plates representing inches and tenths of inches determines which one of the 100 openings in a micrometer valve is open to the closed end of the worktable actuating cylinder.

When one of the openings in the rotary actuator is open to the sump, the moving element of the actuator moves to that angular position which centers the single vane on the element over the opening to the sump. The vane moves to that position because it forms a dividing wall between two chambers each supplied with hydraulic fluid from the pressure supply through carefully balanced restrictions. Until the vane centers over the opening to the sump, the pressure in the chamber not open to the sump is higher than the pressure in the other chamber. The vane is therefore moved toward the opening until leakage to the sump is the same from both chambers.

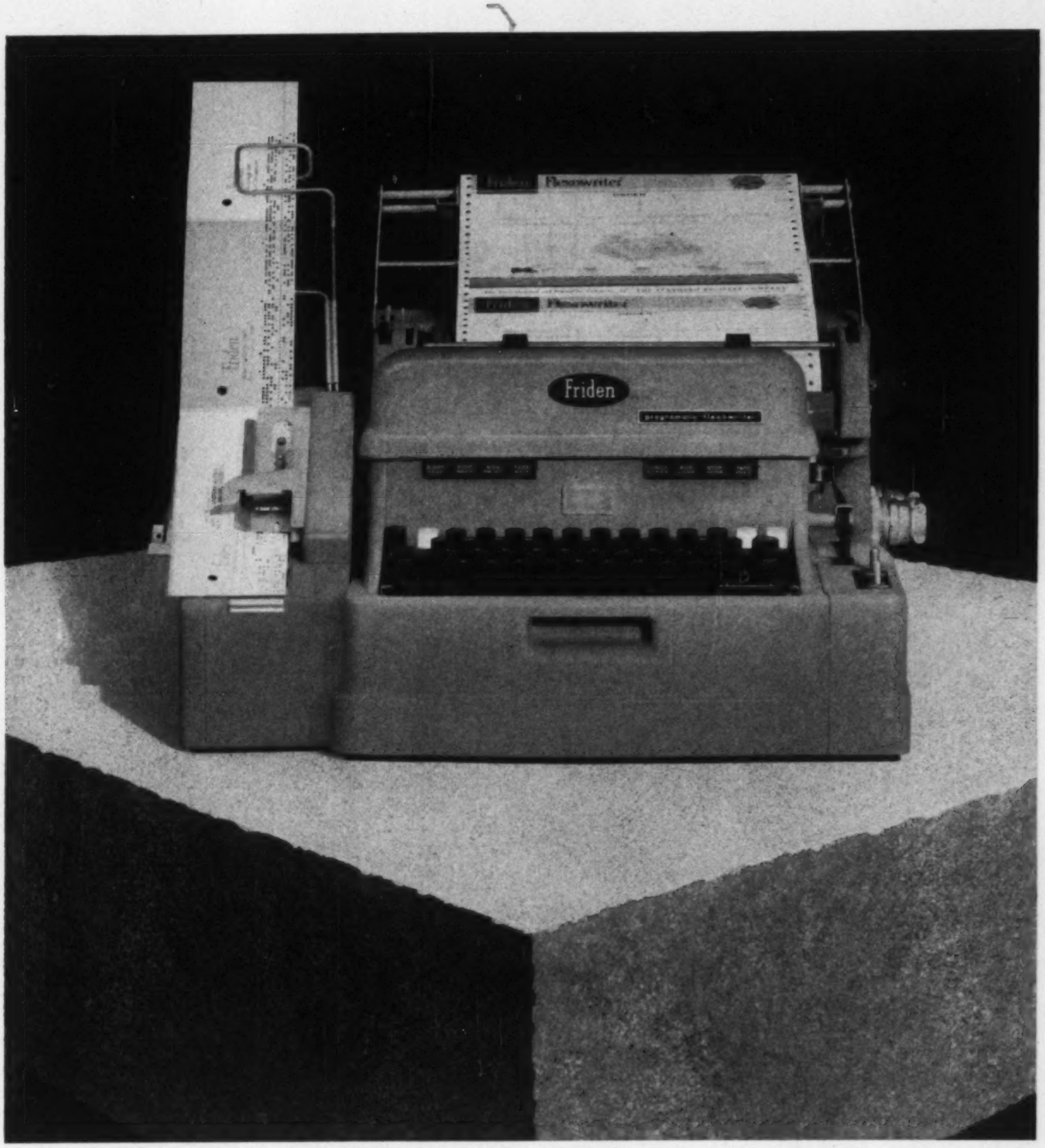
The rotary actuator rotates the spool in the micrometer valve to one of 100 angular positions. This spool has a one-turn helical valve land such that the one hundred increments of rotary position represent a linear distance equal to the displacement from center to center of adjacent openings in the micrometer valve. The rotary actuator under the control of its 8-level selector valve thus provides a vernier adjustment on the null point of the micrometer valve. The coarse adjustment of the micrometer valve is determined by the setting of the inches and tenths 8-level selector valve.

Since the spool of the micrometer valve moves linearly with the worktable, the valve land does not center on the selected opening until the worktable is in the desired position. The worktable is moved to that position by the worktable actuating cylinder. In the simplified sketch, this cylinder is shown directly connected to the micrometer valve. In actual practice an intervening servo valve would be pilot controlled by the micrometer valve to avoid adverse effects on the micrometer valve.

With the area of the piston toward the closed end of the cylinder being twice the area of the piston toward the rod end, the piston moves until the pressure on the closed end is one-half the pressure on the rod end. This point is reached when the pressure on the closed end due to leakage from the pressure source on one side of the helical valve land is reduced to half the pressure on the rod end by the leakage to the sump on the other side of the helical land.



Simplified schematic shows how a machine worktable is positioned along one axis by a pneumatic-hydraulic system. Commands punched in paper tape are sensed by pneumatic circuits which control special selector valves in the hydraulic circuits. Moving of the table and sensing of its position are accomplished hydraulically.



Automation Cornerstone

The Friden Flexowriter® has three basic capabilities: 1) It can type, 2) it can *record* what is typed on punched paper tape, 3) it can *read* tape back to itself, retyping automatically at 100 words per minute.

These things are remarkable, but the important point is this: Tapes produced on the Flexowriter can automatically control a great many *other* machines—those made by other manufacturers as well as by Friden. Thus the Flexowriter performs the key task in automation, *translating human language into a language that machines can understand.*

Applications for the Flexowriter are immensely varied. It allows man to converse with computers. It prepares tapes that control automated machine tools. It's also bringing about a major revolution in the handling of basic business paperwork. And the surface has barely been scratched.

It will pay you to learn more about this machine and the jobs it could be doing for you. Your local Friden Systems Representative is the man to see. Or write: Friden, Inc., San Leandro, Calif.

THIS IS PRACTIMATION: automation so hand-in-hand with practicality there can be no other word for it.

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Circle 681 on Page 35

REULAND MOTORS

NOW, buy only the horsepower you need with
REULAND'S new Hydraulic Pump Motor Intermediate* H.P. Ratings!

Tailor motor h.p. to your pump's performance curve.
Reduce motor costs... increase operating efficiency.

If you're an O.E.M. or user of hydraulic pumps, Reuland's twelve new "in-between" hydraulic pump motor ratings can start saving you money as of *today*. No longer must you pay for overmotoring... no longer must you compromise operating efficiency with an unneeded, over-size motor. *Now you pay by the horsepower... and buy only what you actually need to match the performance curve of the pump!*

Reuland's new intermediate ratings are an important sequel to *another* famous Reuland first... the original, internal spline coupling method of hooking up motor and pump!

All ratings are standard and available for quick deliveries. New price lists and engineering data sent on request. You should have a copy.

Refer to Sweet's 1961 Product Design File, 7a/RE

28 horsepower ratings from ½ through 60... 12 brand new, exclusive, intermediate ratings!

½	¾	1	1½	2	2½*	3
4*	5	6¼*	7½	8¾*	10	12½*
15	17½*	20	22½*	25	27½*	30
32½*	35*	37½*	40	45*	50	60

*Exclusive, new intermediate ratings.

Your copy of this catalog on Reuland Spline Coupled Hydraulic Pump Motors... plus the complete Reuland line... will come in handy. Sent free on request.

MODERN POWER FOR MODERN-DAY PRODUCTS

... all in lightweight, cool-running aluminum frames!

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Western Division: Alhambra, California
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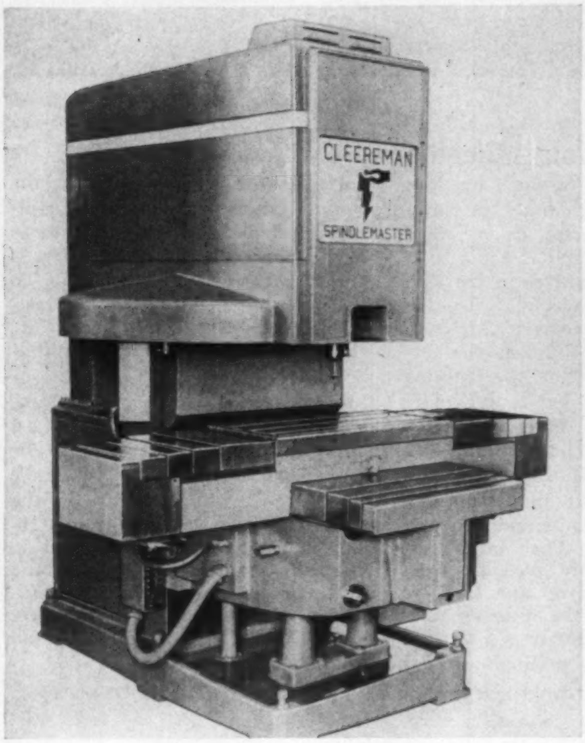
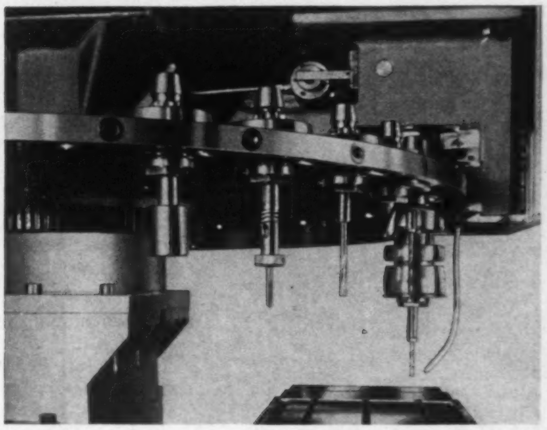
AUTOMATION new equipment

Machines and plant equipment for more automatic operations.

For detailed information and literature, use card page 35.



Tape controlled multipurpose machine is designed to position along 3 axes (single spindle and compound table) and to control 18 spindle speeds from 150 to 3125 rpm. It will control 98 spindle feeds from 0.4 to 19.8 inches per minute and activate a coolant cycle.



Controlled by tape command, tool changer automatically changes tools in less than 8.5 seconds. It selects any of 30 tools from a magazine while the table is positioning for the next operation.

Multipurpose Tape Controlled Machine

DEVELOPED by **Cleereman Machine Tool Corp.**, 601 Elizabeth St., Green Bay, Wis., this multipurpose machine is designed especially for numerical control and the control designed especially for it. It is capable of performing drilling, tapping, boring, reaming, and milling operations. Designated as Spindlemaster, the unit makes tool changes automatically in less than 8.5 seconds and selects any of 30 tools from a magazine while the table is positioning for the next operation—all by numerical control. Through tape commands it will position along 3 axes (single spindle and compound table); control 18 spindle speeds from 150 to 3125 rpm; control 98 spindle feeds from 0.4 to 19.8 inches per minute; activate coolant cycle; and control type of operation.

The spindle cycle is predicated on the operation mode called for. For each operation mode, machine functions occur in a sequence consistent with the operation to be performed. For the boring operation mode, two kinds of spindle cycles can be called for. Upon reaching depth, the boring tool can be either withdrawn from the workpiece at the power rapid traverse rate, or direction of feed can be reversed, without reversing direction of spindle rotation, to retract the tool at the same feed rate at which it is fed down. For precise work, the ability to feed up as well as down produces a better finish, more accurate hole size, and eliminates spiral tool marks.

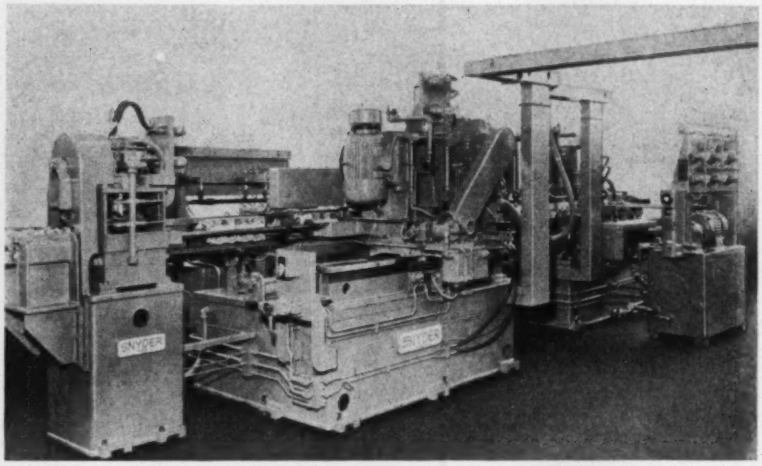
To provide a variety of working heights, the table and carriage are mounted on an adjustable knee with twin raising screws to prevent deflection. The table has 8 inches of vertical adjustment in 1-inch increments. A tape command illuminates one of eight lights on a height setting gage located at the left side of the knee to indicate which table height position is required. Specifications include: Spindle travel, 9.999 inches; table size, 30 by 16 inches; table travel, 24 by 16 inches; part clearance, turret to table 18 inches maximum; maximum part size, 18½ by 30 by 16 inches wide; maximum tool diameter, 4 inches. Additional information may be obtained by writing the Jackson-Fotsch Co., General Distributors of Cleereman Machine Tool Corp., 7350 W. Lawrence Ave., Chicago 31, Ill.

Circle 401 on Page 35

Well Test and Data Panel

System has been developed to determine the amount of oil, gas, and water produced by individual wells. Model WT-300 is designed to automatically test 25 or any multiple of 25 oil wells. Each 25-well module is equipped with a purge timer, test timer, and skip-test well selector switches. Oil, gas, and water counters are provided for tabulation and storage of data during test. Typed data consists of the volume of oil, gas, and water, date, time, and well code number —this information is printed in a maximum of 10 seconds. The panel may be located either in the central office or in the field, using a 2-wire communication system or microwave for transmission to the central office. **Instruments Inc.**, P. O. Box 556, Tulsa, Okla.

Circle 402 on Page 35



Intake Manifold Machine

Eight-station transfer machine 24 feet long rough mills the cover face, exhaust bosses, construction bosses, joint face and intake face of aluminum automotive engine cylinder heads at a rate of 120 pieces per hour at 100 per cent efficiency. Machining of alumium on the machine requires that the milling spindles turn at speeds providing 5000 sfpm. Coolant is fed to the work through hollow spindles to improve flow to cutting edges. Machine consists of four segments: Two machining units and two part orienting units. The rough cast cylinder heads are received from the factory conveyor line and are moved through the transfer machine by a rotating-finger transfer mechanism. Each milling unit has two stations. To avoid marking of surfaces after they are milled, the milling heads feed against the direction of part travel and return to starting position as the part is transferred to the next station. To make certain that parts are correctly clamped in each milling station, the milling sequence is not initiated unless air holes in rest buttons are sealed. This electrically controlled, hydraulically operated transfer machine has two hydraulic power packs to supply hydraulic power. The milling head in the first segment has 5, 7½, and 10-hp motors. The milling head in the third segment has a 10 hp and 25-hp motor. An automatic lubrication system is included. **Snyder Corp.**, 3400 E. Lafayette, Detroit 7, Mich.

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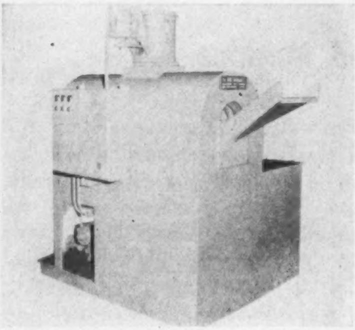
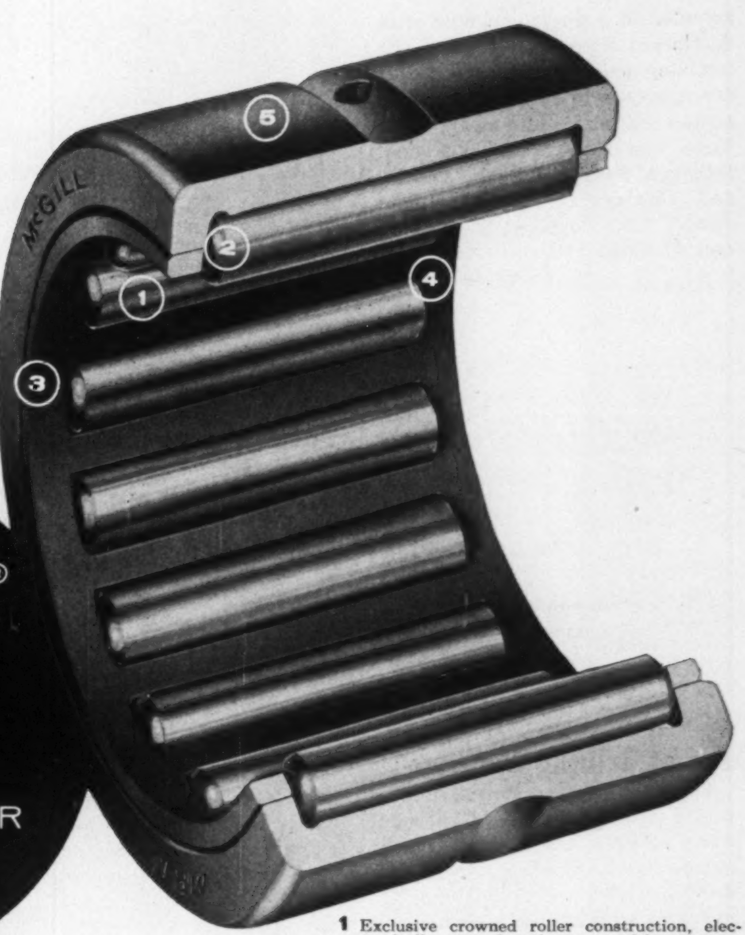


Continuous Cleaner

Drum-type cleaning machine is designed specifically for volume cleaning of small parts. It is suitable for stampings, castings, and machined parts. Parts are conveyed through the machine by a worm inside the drum, passing through a soak, a spray, and a drain section before being automatically discharged. The unit has a variable speed drive which provides capacity ranging from 6 to 9 cubic feet of parts per hour. It is completely self-contained, incorporating cleaning solution pump and motor, variable speed drive and motor, ventilating blower and motor, solution temperature controls, and solution tank with access door to solution-filtering screens. The solution tank may be heated by steam, gas, or electricity. Motor controls are



NEW

CAGEROL®

CAGE TYPE
HEAVY DUTY
NEEDLE ROLLER
BEARING

BY McGILL®

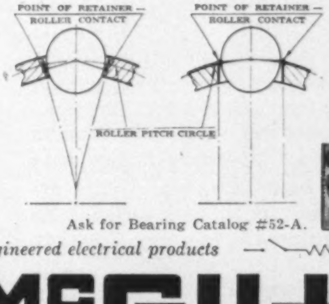
1 Exclusive crowned roller construction, electronically gauged to insure precision contour and size uniformity. Relieved ends assure even load distribution.

2 Flat ends fully engage integral race shoulders, provide maximum support.

3 Proper guidance assured by tapered retainer pockets. The design insures *balanced* roller support and eliminates corner wear from edge loading of straight pockets where retainer OD and pitch circle are coincident.

4 Simultaneously punched pockets assure accuracy of race and roller alignment. The black ferrous oxide retainer finish absorbs and retains lubrication, reducing the friction coefficient.

5 SAE 52100 steel outer race has optimum hardness and surface finish.


POINT OF RETAINER — ROLLER CONTACT
POINT OF RETAINER — ROLLER CONTACT
ROLLER PITCH CIRCLE

Ask for Bearing Catalog #52-A.

INCREASE EXPECTED LIFE UP TO 10 TIMES!

You need CAGEROL bearing performance if higher speeds and increased misalignment have prevented the utilization of needle bearing load capacity in your applications. Most important, CAGEROL bearings can deliver up to 10 times more expected life where misalignment and increased speeds exceed the capabilities of ordinary and guided needle bearings. The difference is in the exclusive McGill construction that features tapered retainer pockets for balanced roller guidance, crowned rollers, and black oxide retainer finish. CAGEROL bearings are interchangeable with all heavy duty needle roller bearings — with or without inners in two bore sizes.

McGILL MANUFACTURING CO., INC., Bearing Division
401 N. Lafayette Street, Valparaiso, Indiana

engineered electrical products

McGILL®

precision needle roller bearings

Circle 683 on Page 35

mounted in a single enclosure with interlocked disconnect switch. The tumbling action of the parts as they are conveyed through the machine assures efficient cleaning in both soak and spray sections and thorough draining as well. **Cincinnati Cleaning & Finishing Machinery Co.**, Hageman St., Cincinnati 41, Ohio.

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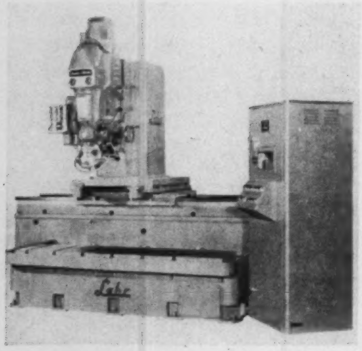
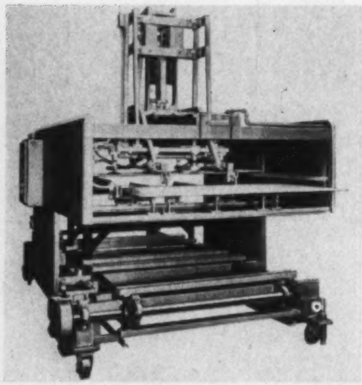


Turret Drilling Machine

Designed for numerically controlled drilling operations of large pieces or parts, especially long and narrow work, large-capacity turret drilling machine offers dialing of dimensions with manual operation of spindle upon positioning. It also offers positioning and fully automatic cycling where repetitive operations are following subsequently. Machine is equipped with a Warner & Swasey Probomat system of control. The stationary table permits loading of work so that the drilling operations can be completed without a change of setup. A number of small jobs can be positioned to run consecutively without change. Stationary work area is 20 by 90 inches (illustrated). Other lengths are available. The spindle is moved front-to-back and right-to-left providing *X* and *Y* co-ordinates controlled by tape. Turret head has six faces and can be either power or manually indexed. Spindles have 5 hp two-speed motors with speeds from 125 rpm. Feeds are infinitely variable with each spindle and are preselective from 0.0025 to 0.021 inch per revolution. Tapping can be done on any spindle. **Lahr Machine & Tool Corp.**, 3400 Maplewood Ave., Toledo 10, Ohio.

Circle 405 on Page 35



Vacuum Cup Destacker

Destacker and sheet feeder is designed to lift one sheet at a time from the top of a stack of blank sheets, index forward, and deposit the sheet on the feed station. It incorporates a heavy duty stock index conveyor which will hold two or more stacks of blank sheets. When pallets or dunnage are used the stock index conveyor is built with an empty pallet removal station. This destacker is completely self-contained, floor-mounted, does not require a pit or foundation, and includes both automatic cycling and manual inching controls, as well as sheet separator. It is made in various sizes and arrangements to suit any particular application. **Die & Automation Inc.**, 5353 Dixie Highway, Hamilton, Ohio.

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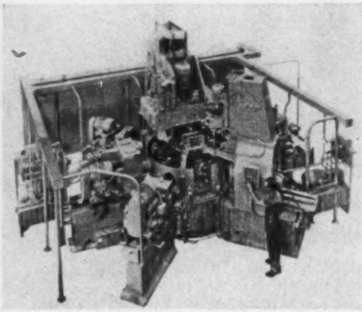
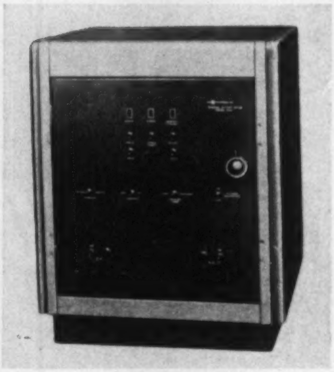


Indexing Machine

Eight-station horizontal and vertical indexing machine, developed to process aluminum steering gear housings, produces 153 housings per hour performing rough and semifinish boring, generating, drilling, countersinking, tapping, and crossfacing operations. Its 52-inch table, mounted on frictionless bearings, is automatically indexed by a fluid motor actuating a worm and wheel and is located with a hydraulically actuated shot pin. The machine's multiple spindle heads were designed to accommodate change gears in order to vary spindle speeds. Its complete coolant system provides for disposal of aluminum chips. **Greenlee Bros. & Co.**, Rockford, Ill.

Circle 407 on Page 35



Magnetic Memories

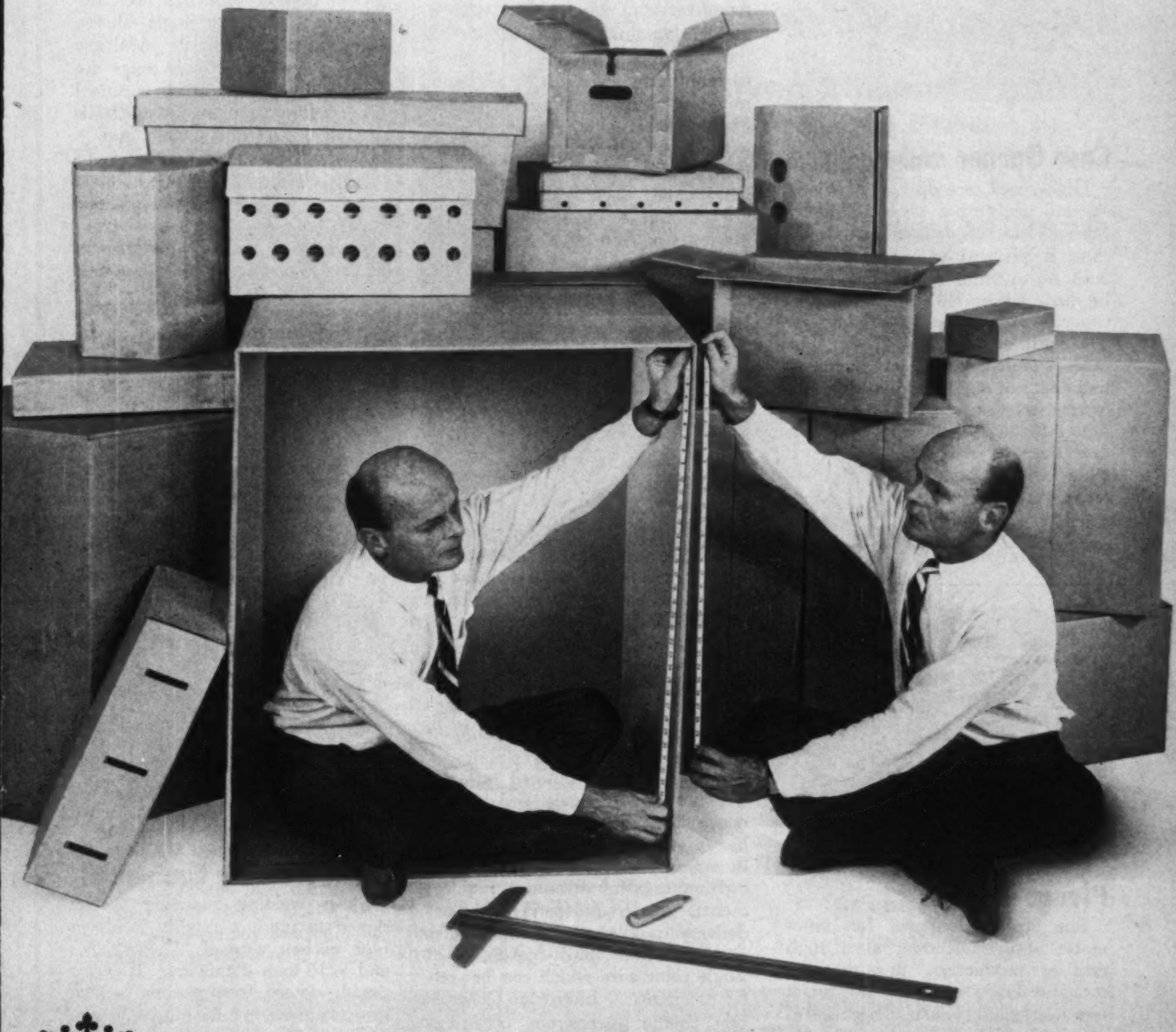
High-speed coincident-current, random access storage units have a range of storage capacities from 128 to 4096 words and from 4 to 64 bits per word. They permit exact match of memory to arithmetic operations, instruction storage, editing, telemetering, multiplexing and data distribution, communication links and displays, and a multitude of data processing and control equipment. Operating with address-to-address cycles as low as 10 microseconds, Series 3100 transistor operated memories accept digital information either synchronously or asynchronously. They store the information in randomly specified or sequential addresses, and can be supplied with binary or binary coded decimal address. They require only data and address signals and a read or write cycle start pulse from external data processing equipment. Input signals may be pulses or levels at 0 or −6 volts. Input-output data may be transferred in parallel or in series by an in-out shift register. Output data are taken as a level from flip-flop register at 0 or −6 volts. Memories are available with internal clock timing source, pattern generation, and self-checking

Circle 684 on Page 35→

GAYLORD SOLVES PACKAGING PROBLEMS INSIDE AND OUT

Your Gaylord Man isn't twins, he just works like it. He knows the "inside" of container manufacture and the "outside" of packaging operations, so he can give you double-duty service.

Got a packaging problem or two? Call the man who solves them by the pair—your nearby Gaylord Man. Today.



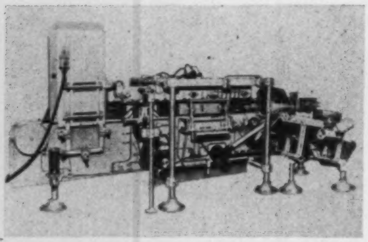
CROWN ZELLERBACH CORPORATION
GAYLORD CONTAINER DIVISION

IN CANADA • CROWN ZELLERBACH CANADA LTD. VANCOUVER, B. C.

HEADQUARTERS, ST. LOUIS
PLANTS COAST TO COAST

circuits. Temperature range of the units is from 0 to 50 C without auxiliary cooling, and line requirements are from 100 to 130 volts, 60 cycles. Units to operate at other frequencies are also available. **Rese Engineering Inc.,** 731 Arch St., Philadelphia 6, Pa.

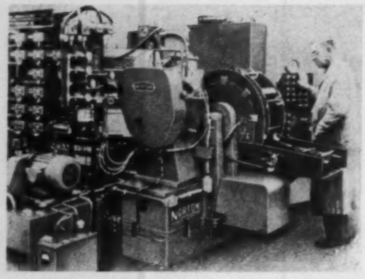
Circle 408 on Page 35



Case Opener and Packer

High-speed case opener, positioner, and packer has been developed for packing rectangular cartons or cans. It has positive automatic feed with no operator required and can be made adjustable with production capacity up to 25 cases per minute. The unit can handle all types of cases—stapled, glued, or stitched—and does not require special shipping cases or tolerances. It will run standard mill shipments of corrugated cases, and also will accumulate a wide variety of carton loading patterns. **A-B-C Packaging Machine Corp.,** Tarpon Springs, Fla.

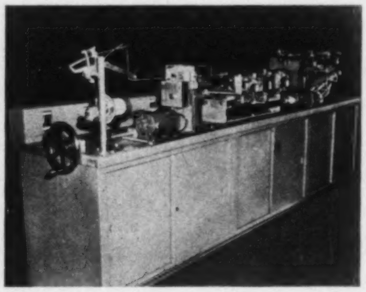
Circle 409 on Page 35



Plunge Grinder

Specifically designed for automatic plunge grinding at a high rate of production, this machine provides for a semistandard turret type automatic loader. Because of its building block design, it is possible to use the same loader, with modifications, for a wide variety of parts and reposition the wheel slide on the rear base for angular or straight work. Designated as Model CP-1 Plunge-O-Matic, this 15-hp grinding machine incorporates a newly designed feed. It is equipped with an automatic wheel contact accelerator that eliminates grinding air and shortens the cycle time. An automatic wheel wear compensator automatically compensates for reduction in grinding wheel diameter after each truing cycle. The variable speed wheel drive motor is controlled automatically by the action of the diamond-carrying ram of the truing device. Nominal work capacity of the machine is 18 and 30 inches. Maximum swing is 39 inches, and nominal swing 10 and 14 inches. Maximum diameter of work ground with a 36-inch wheel is 15 15/16 inches. Maximum and minimum wheel and work center distances are 26 and 8 inches respectively. **Norton Co.,** Worcester 6, Mass.

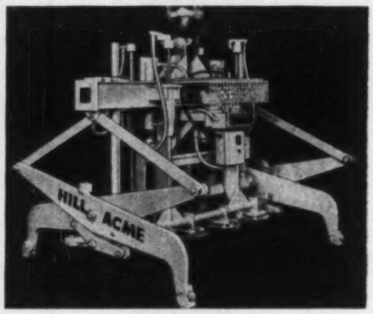
Circle 410 on Page 35



Wire Color Coder

Teflon wire coding machine automatically dereels, straightens, color codes, thermal strips and cuts to length a wide range of wire sizes. Duplicate sets of up to six bands of different colors can be simultaneously applied and sintered into the Teflon surface for easy and permanent identification. Spacing of bands and cutoff lengths are readily adjustable. The unit offers reduction in wire inventory requirements, greater independence from delivery problems, and economies resulting from bulk purchase of single color wire which can be coded as needed. **Industrial Controls Div., Radio Corporation of America,** 12605 Arnold Ave., Detroit 39, Mich.

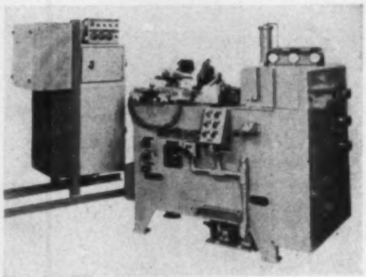
Circle 411 on Page 35



Sheet and Billet Lifter

Combination unit has been developed to handle single sheets, slabs, billets or ingots. Multiple vacuum cups or scissors tongs are used as required. Lifter is suited for handling nonferrous materials as well as ferrous metals and is made in sizes and capacities to fit various requirements. Unit illustrated has a tong capacity of 8000 lbs and a vacuum lift capacity of 1200 lbs both with adequate safety factors. The tong action of the unit is automatic and the face of the material being handled is protected by supporting rollers attached to the tong arms. The frame supporting the vacuum cups is actuated by air cylinders controlled by a solenoid valve, and the lifter incorporates its own vacuum system including motor, pump, and vacuum reservoir. **Hill Acme Co.,** 1201 W. 65th St., Cleveland 2, Ohio.

Circle 412 on Page 35

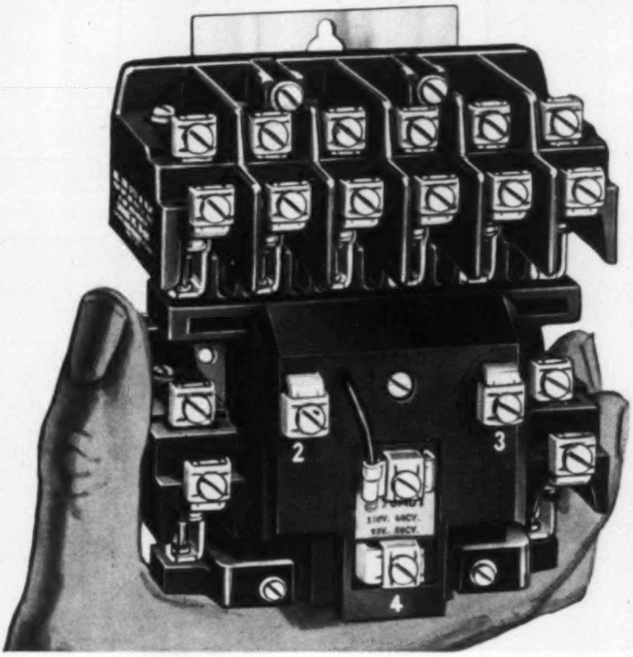


Flash Welding Equipment

Flash welding machine is designed to produce quality welds in high carbon wire of ¼, 9/32, ⅜, and 9/16-inch diameters. It has a timed, forced control mechanism for synchronizing flashing and upset and an automatically controlled system for normalizing the weld area. Designated Model F-1, this ma-

Circle 685 on Page 35→

NEW Allen-Bradley Relay with EXCLUSIVE Permanent Magnet Latching



Saves Panel Space

Gives Millions of Trouble Free Operations

Holds Closed Without Coil Current

Two to Six Poles

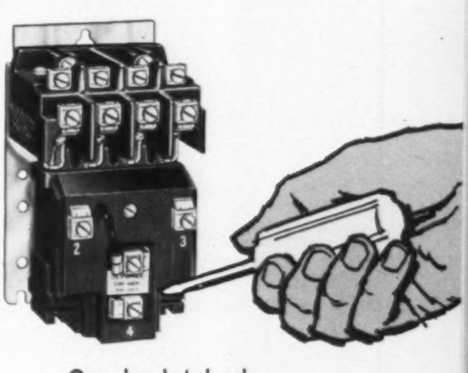
Bulletin 700 | **TYPE BRM**

Here's a completely new "latching" relay—which does not use a mechanical latch! It is the Bulletin 700 Type BRM—built to provide the same millions of dependable operations you get from all Allen-Bradley's industrial relays. A "built-in" permanent magnet eliminates the mechanical latch and the usual troubles caused by mechanical linkages.

When the coil of the new Bulletin 700 Type BRM relay is energized, the relay closes and is held closed after the coil circuit is opened—by a permanent magnet. Energizing the coil in opposition to the permanent magnet field opens the relay. The correct polarity for operation of the relay is obtained from silicon diodes held within the molded coil cover. With no "piggy-back" additions out in front, and no "extra" solenoids below, the Type BRM relay saves valuable panel space.

These A-B Type BRM relays also feature a continuous duty coil that permits the current to be left on, if desired. As with all Allen-Bradley relays, the double break silver contacts never need attention. And the contacts of these new magnetically latched relays afford the same 60-second convertibility of the popular Bulletin 700 Type BR relay.

For latching relay service, it will pay you to investigate this new and completely different relay. It provides the usual Allen-Bradley quality!



Can be latched
or unlatched by hand

ALLEN-BRADLEY

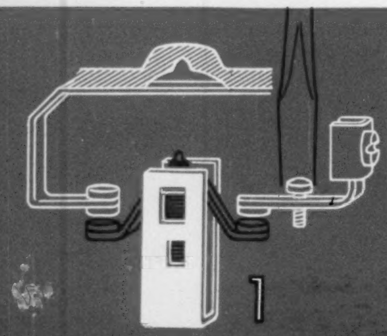
Member of NEMA

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

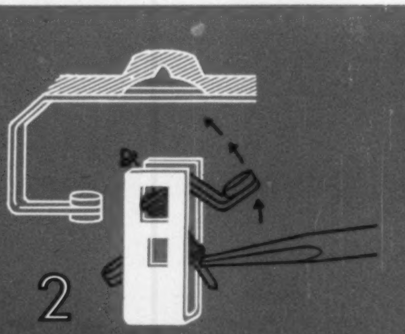
QUALITY MOTOR CONTROL

Four simple steps to contact changeover

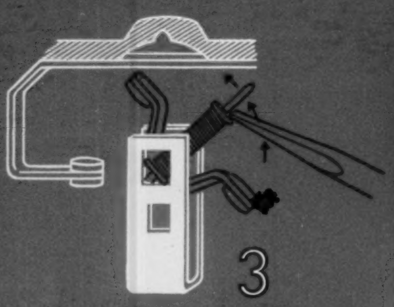
Total time—not more than 60 seconds



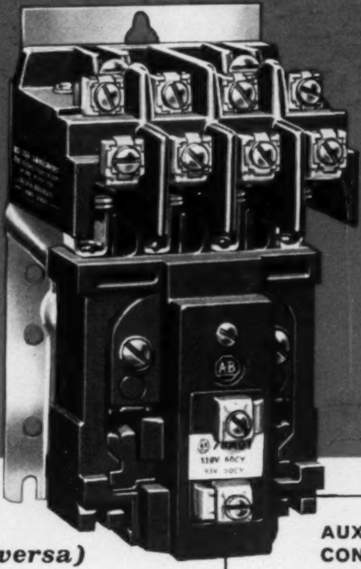
REMOVE FRONT STATIONARY TERMINAL

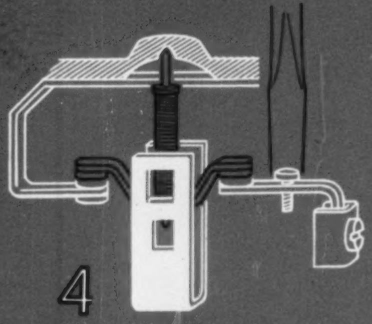


LIFT CONTACT SPRING AND ROTATE



DEPRESS SPRING AND
TURN PIN STRAIGHT UP





REPLACE TERMINAL
IN REVERSE DIRECTION

Converts from N.O. to N.C. (or vice versa) in 60 SECONDS!

You'll be truly amazed at the ease of converting the contacts on these Allen-Bradley Bulletin 700 Type BR relays. Using only a screwdriver, as shown above, the contacts can be changed from N.O. to N.C. (or vice versa) in four easy steps—that take only *60 seconds!* Such convenient flexibility is a "natural" for reducing relay inventories.

The Type BR relays are built to provide *many millions* of trouble free operations. With the built-in permanent air gap, magnetic sticking is impossible. And the molded coil is impervious to *all* harmful atmospheres. Of course, the double break, silver contacts *never* need attention. If you use relays, there are money savings for you in the Type BR relay line!

AUXILIARY CONTACTS EASILY ADDED

Type BR relays are available with 2, 3, 4, or 6 poles—but as a valuable bonus, one or two fully rated poles can be added to the base of each relay—even in the field. It's a simple addition that takes only moments.

ALLEN-BRADLEY

Member of NEMA

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis. • In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

QUALITY MOTOR CONTROL

1-61-RH

chine is highly effective for joining wire coils and is applicable in many wire drawing plants. A water-cooled transformer rated 30 kva at 50 per cent duty cycle and a series-parallel switch provide 16 points of heat. The welding cycle is controlled by a Thomson Synchromatic mechanism that provides a true parabolic flashing curve. **Thomson Electric Welder Co.,** 161 Pleasant St., Lynn, Mass.

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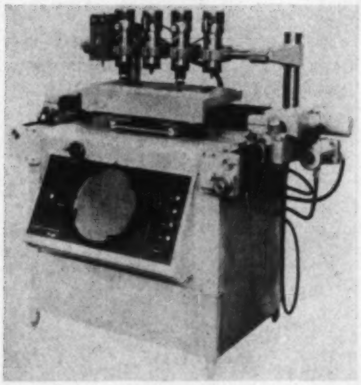

Circuit Board Drill

Applicable to both the electronics and electrical industries, this high-speed circuit board drilling machine is designed to increase hole-positioning accuracy to one-thousandth of an inch and save a substantial number of man-hours in programming. With a magnetic tape control and an average positioning time of less than one second, the MPI 440 circuit board drill is capable of drilling 40 holes per minute with each drill head. The machine's optical programmer is essentially a comparator equipped with a large viewing screen. Positioning of a master while observing on the viewing screen allows recording of command positions. Playback for the unit is four times its programming rate. On a table 20 by 30 inches, the machine also has the capability of routing contours or dividing multicircuit boards into individual boards. The joy stick used for programming and routing is a velocity control having an exponential response such that relatively large movements from its vertical position produce slow movements on the drill table. This design makes precise control easy. Maximum speed of 100 inches per minute is obtained when the joy stick is moved to near the limit of its range. **Micro-Path Inc., Subsidiary, United Industrial Corp.,** 5221 W. 102nd St., Los Angeles, Calif.

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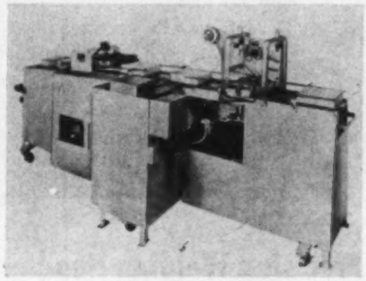

Tape Applying Machines

Line of multipurpose tape applying and combining machines incorporates "Scotch" brand flat surface applicator taping heads. Machines combine and tape together boxes, cartons, packages, etc., of varied sizes and shapes. Objects are combined and tape is applied on one or both sides of the objects in one operation. Machines can be hopper or manually fed and can combine and tape up to 150 boxes per minute. They can be used to index and register printed tape. Machines are made with co-operation of Minnesota Mining and Manufacturing Co. **Lened Mfg. Co. Inc.,** 489 Henry St., Elizabeth, N. J.

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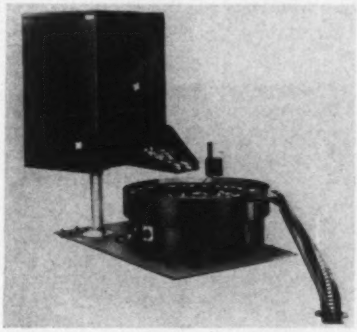

Parts Handling System

Fully integrated parts handling system is available for high-speed manufacturing, assembling, counting, and packaging operations. It is comprised of a vibratory parts feeder, designated the Automator, to orient the parts into the required position and feed them into a chute for delivery to the use point where an escapement releases them. It also includes a vibrating storage-supply hopper to supply the feeder bowl on demand of a bowl level limit switch. The feeder has a feed rate of up to 90 feet per minute, and is available in standard sizes of 5, 8, 12, 18, 24, 30, and 36-inch diameters with either clockwise, or counter-clockwise feed direction. The vibrating storage-supply hopper is available in sizes of 1, 2, 3, 4, 7, and 10 cubic foot capacities. Other sizes are also available. The bowl level limit switch is infinitely adjustable to control any required maximum-minimum depth of parts in the feeder bowl. **General Automation,** 2315 W. Magnolia Blvd., Burbank, Calif.

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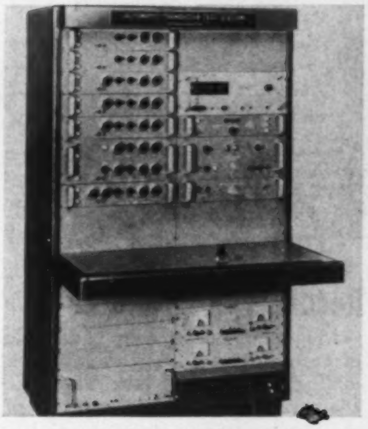

Semiconductor Tester

Unit was developed to meet the need for increased quality in production and incoming inspection testing. It features completely automatic high-speed testing with evaluation of transistor or diode performance accomplished by means of a precision *Go, No-Go* comparator. Up to 700 semiconductors may be tested per hour with 100 per cent measurement reliability. Silicon or germanium transistors or diodes may be tested. Selection of any of over 100 measurements is readily accomplished by means of modular components. Power ratings are from 0 to 100 volts and up to 3 amperes. Programming is by means of 10-turn dials and selector switches. Readout is *Go, No-Go,* digital display, automatic typewriter printout, or punch card. Test accuracy is one per cent. Standard tests are leakage currents, breakdown voltages, saturation voltages, dc gain, and small signal measurements. Up to 25 individual tests may be included in any sequence. Counters tally all starts and rejects. **Optimized Devices Inc.,** 864 Franklin Ave., Thornwood, N. Y.

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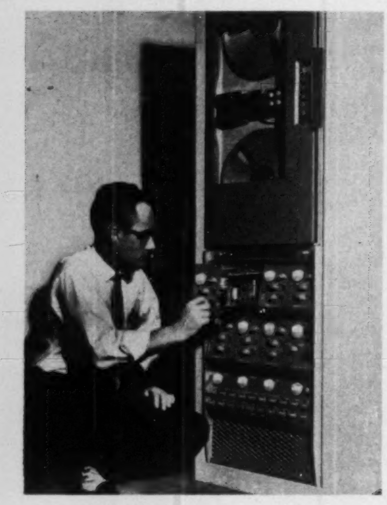

Recorder/Reproducer

Magnetic tape system is capable of recording and reproducing both analog and pulse signals. Its single $\frac{1}{2}$-inch tape travels at any one of six speeds ranging from $7\frac{1}{2}$ to 120 ips. At 60 ips, Model CM-100 can record frequencies up to 500 kc; at 30 ips, 250 kc, and at 15 ips, 125 kc. This video band recorder/reproducer combines the capabilities of two machines in one. Each of the seven video tracks covers an over-all bandwidth of 400 cycles to 1.0 megacycle. Electronics for both recording and reproducing are combined in a single module for each track. In the megacycle range, the system can record at 120 ips one microsecond pulses spaced one microsecond apart and then can increase the time axis of the pulses by 16 so that they can be assimilated by a computer to reduce the data. **Mincom Div., Minnesota Mining and Mfg. Co.,** 2049 S. Barrington Ave., Los Angeles 25, Calif.

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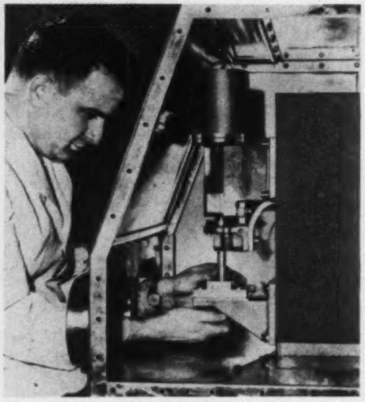

Precision Welding Head

Device is adaptable to dial feed or in-line feed for automated production. It is compact enough to be installed in a standard dry box in which transistors and other electronic components are assembled. This precision welding head makes possible the use of lower welding currents and lower electrode pressures. The air chamber of the *M* welding head combines low inertia with fast action and protects the work with a new cushion feature. An electronic timer provides for precise welding control. Welding action is initiated by foot or palm switches or by automatic programming. Designed for use with either dc or ac welding power supplies, this head is rated at 2700 watt-seconds dc or 50 kva ac. **Commercial Apparatus & Systems Div., Raytheon Co.,** Production Equipment Operations, 84 S. Bedford St., Manchester, N. H.

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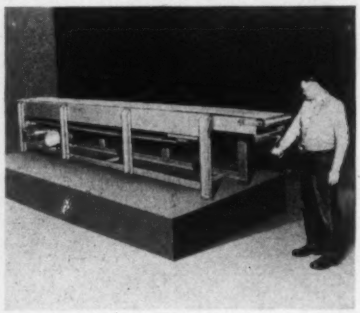
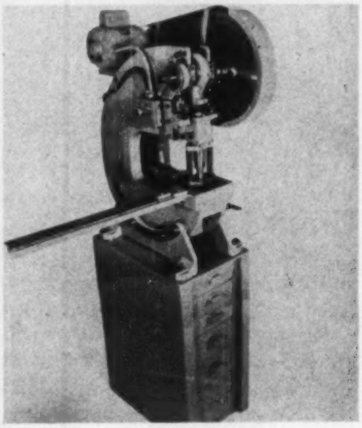


Extendable Conveyor

Specifically designed for use in handling packages and parcels between trucks and docks, or in other areas where loading and unloading are involved, stationary or portable, extendable conveyor extends from a closed length of 15′ 4″ to an extended length of 25′ 8″. Designated the Project-O-Veyor, this conveyor is equipped with a belt riding on a slide bed. Currently available in an 18-inch belt width, the device is designed to handle a live load of 40 lbs per lineal foot. It will handle a single package or parcel weighing up to 200 lbs. Speed may be varied from 30 to 90 feet per minute. The conveyor can be made available in other lengths and widths to meet specific conditions and power can be applied to the length adjustment. **Standard Conveyor Co.,** North St. Paul 9, Minn.

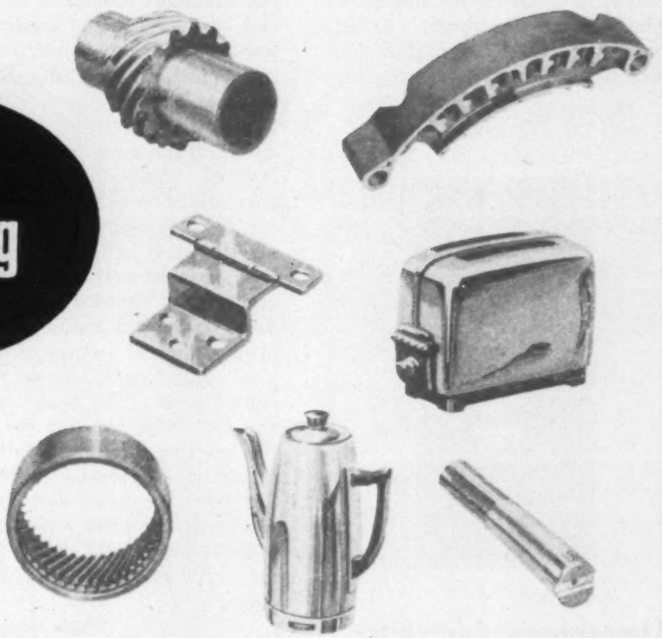
Circle 420 on Page 35



Punch Press

Five-ton open-back inclinable punch press with a 12-inch depth of throat is designed for high-speed production operations. The throat depth allows working to the center of a 24-inch sheet. Flywheel speed is 210 strokes per minute, and the machine can be set up for continuous operation at this rate by removing the cam from the trip mechanism. Practical rate for single stroke cycling of the press would be 150 strokes per minute. Besides perforating or blanking metals, the press can also be used for plastics, felts, leathers, rubbers, and gasket materials. It has a one-piece frame reinforced at all points. Standard equipment on Di-Acro punch press No. 5 includes motor, brake, flywheel guard, stripper assembly and punch and die holders. Accessory

Have a Metal Cleaning Problem



Detrex Engineers Have Been Coming Up With "Cost Saving" Answers for 30 Years

Every metal cleaning operation has its own particular problems—but they're seldom new to the Detrex engineer. With 30 years of experience, he can produce the right formula to insure maximum productivity and economy in your operation.

He will analyze your product, the type of soil to be removed, the proper equipment and cleaning agent needed, the space and manpower required—every factor that bears on the problem.

When he gives you his recommendation, you can depend upon it to make sense—and save dollars. And when you put his recommendation into practice, you can depend upon Detrex to follow through with the finest service in the business.

Depend on DETREX for Every Metal Cleaning and Processing Need

- PERM-A-CLOR NA (Trichlorethylene)
- Solvent Degreasers
- Ultrasonic Equipment
- Industrial Washer
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- Aluminum Treating Compounds
- Alkali and Emulsion Cleaners
- Rustproofing Materials
- Extrusion and Drawing Compounds
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DETREX CHEMICAL INDUSTRIES, INC.
Box 501, Dept. A-161, Detroit 32, Michigan

World's Largest Exclusive Producer of Cleaning Chemicals and Equipment

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equipment includes a device which consists of a die holder and adjustable back and side gages. **O'Neil-Irwin Mfg. Co.**, 724 Eighth Ave., Lake City, Minn.

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Atmosphere Controller

Unit has been developed to meet an increasing need for practical means to maintain precision control over the carbon potential for the gaseous atmosphere in heat treating furnaces. Dewpoint is not used as the control basis; the controller continuously senses the dependably constant temperature-carbon relationship in a small burning sample of the furnace gas. The sensing element, through a recording controller and servos, promptly and accurately corrects the atmosphere. **Rolock Inc.**, Fairfield, Conn.

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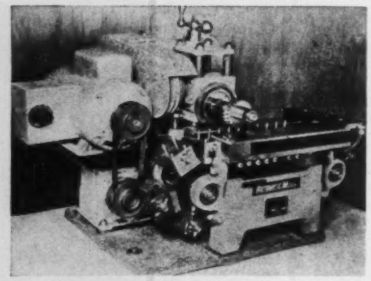

Milling Unit

Capable of production milling rates as high as 6000 parts per hour, unit may be attached to the end of any milling machine. A self-contained unit with built-in milling head is also available. The units can maintain tolerances of ±0.001 inch in the milling of precision electronic components as small as 0.050 by ¼ inch as well as tool bits as large as 1 inch square. In operation, the chain drive continuously moves as the parts to be milled are inserted. Individual self-contained jaws apply pressures from 50 lbs up to ½ ton per jaw, firmly holding the parts in the jaw cavities as they pass beneath the cutter and are milled. The carrying bases continue beyond the hardened ways allowing internal springs to open the jaw cavities and release the machined parts. The chain drive carries the bases beneath the unit to the starting position where built-in air wipers remove all chips and dirt from the bases and jaws prior to re-entry into the ways where the cycle is continued. **Baird Machine Co.**, 1700 Stratford Ave., Stratford, Conn.

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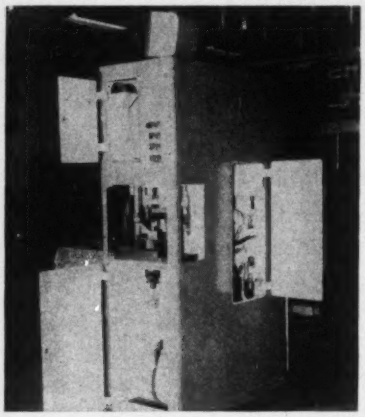

Hydraulic Press

Machine has been designed specifically for the compaction of powdered metals, glass, and plastics. The unit illustrated is a one-ton, top and bottom ram press specially tooled for volume production of tantalum capacitor anodes. It is adaptable to a variety of powdered metal compaction operations, including ferrous, nonferrous, and exotic metals. Only tooling modifications are necessary for these adaptations. Cycle time of the press is 25 per minute, and higher speeds are possible with proper powder control. Maximum fill capacity of die is 1¼ inches compacted with diameters from 0.040 to ⅜ inch. Wire diameters may range from 0.016 to 0.025 inch. This multicompaction press holds length variations to tolerances of 0.005 inch and density variations to 1 per cent of specification. The wire feed mechanism will feed 1 inch maximum length of wire per stroke with maximum ¼ inch adjustment. The press is powered by a 3-hp, 1200-rpm electric motor. It can be run either single cycle or auto cycle, but is designed primarily to operate as untended automatic production tool. **Denison Engineering Div., American Brake Shoe Co.**, Columbus, Ohio.

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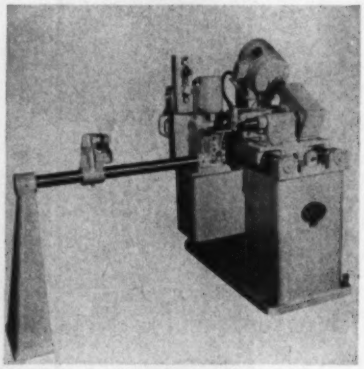

Centering Machine

Unit is designed to prepare cylindrical work for turning and grinding. It mills workpiece ends, deburrs them, and drills centers within 0.002 inch of specified depth. It will handle workpieces up to 3 inches in diameter and 3 feet long, or longer with an extension work rest. The machine will hold length between center holes to ±0.006 inch. The milling cutter can be set to simply dress the workpiece ends square, or to mill them to a precise dimension so that over-all length of the workpiece is held to ±0.0025 inch tolerance across the entire end faces. The deburring cutter can be set for a light kiss cut or a deep chamfer. Spindle speeds vary as follows: Center spindle, 2430 rpm (direct work drive); milling and deburring spindles, 360 rpm and 85 rpm (spline drive, quill feed). **National Automatic Tool Co. Inc.**, Richmond, Ind.

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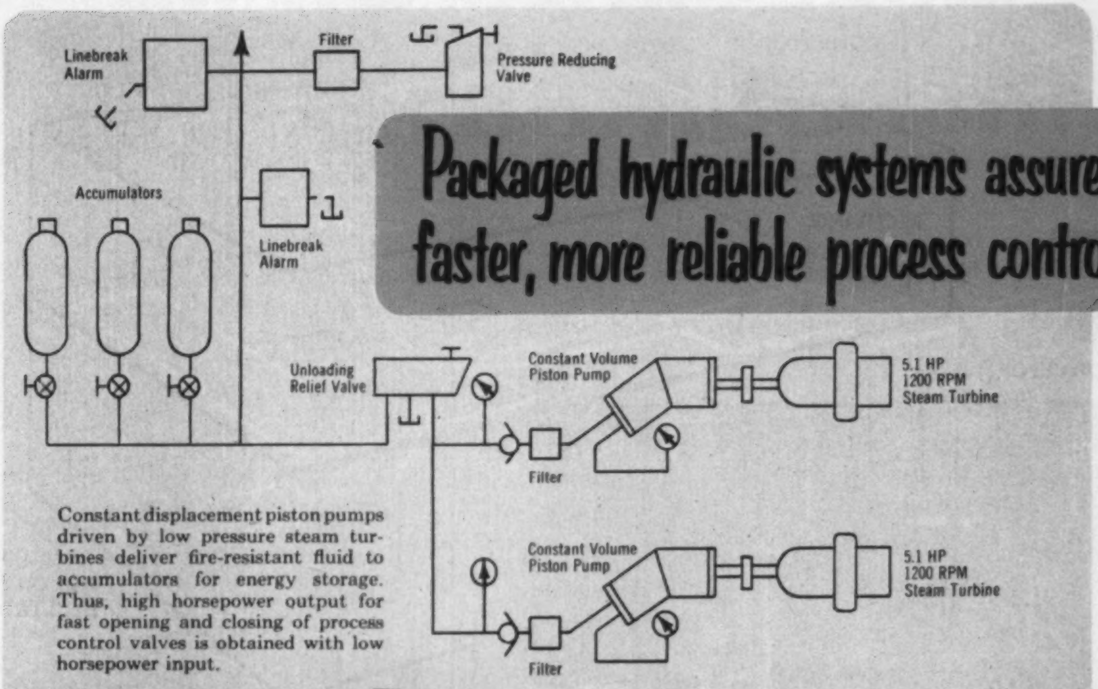
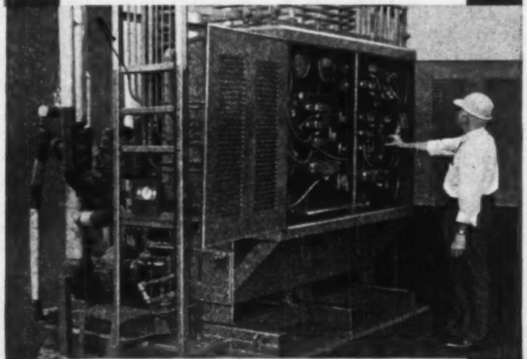
Packaged hydraulic systems assure faster, more reliable process control


Linebreak Alarm
Filter
Pressure Reducing Valve
Accumulators
Linebreak Alarm
Unloading Relief Valve
Constant Volume Piston Pump
5.1 HP
1200 RPM
Steam Turbine
Filter
Constant Volume Piston Pump
5.1 HP
1200 RPM
Steam Turbine
Filter

Constant displacement piston pumps driven by low pressure steam turbines deliver fire-resistant fluid to accumulators for energy storage. Thus, high horsepower output for fast opening and closing of process control valves is obtained with low horsepower input.

Control console and power unit form electro-hydraulic system for controlling automatic heat treatment cycle. Physical layout provides optimum circuit efficiency, ease of servicing, and good appearance.



This power package includes all hydraulic pumps and valves for complete control of automatic cyclic operation of process in a butadiene plant.

Fast and precisely controlled motions, having the high reliability demanded by modern processing, are inherent characteristics of hydraulics. In addition, these advantages are obtained at low cost, for you can cover your full range of operations—from valve control to power transmission—with standard Vickers components. Your engineers enjoy unlimited design flexibility through a choice of electric, electronic, pneumatic and manual signals to control the hydraulic pumps, motors, cylinders, and variable speed drives.

Vickers complete packaged systems are ready to go into service upon arrival in your plant, since they are thoroughly pretested before shipment. They are properly designed and built to give maximum service life with little downtime, thus helping to keep your plant on stream.

Get more information on the job being done by Vickers packaged hydraulic systems in chemical, petrochemical, petroleum refining, and other processing industries by writing today for Bulletin I5802, "Packaged Hydraulic Systems for Process Control."

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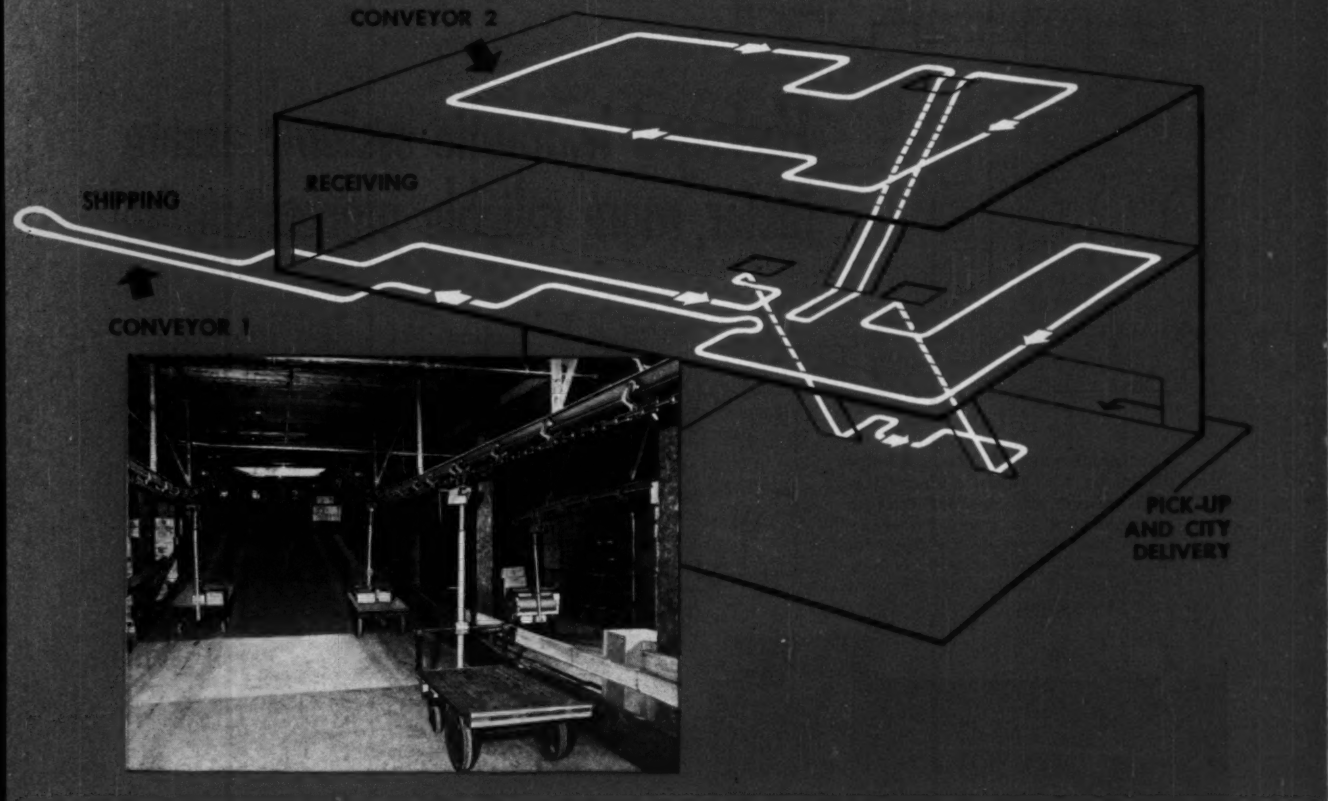
WEBB TOW-CONVEYOR SYSTEM



Modernizes Handling In Three-Story Warehouse

FASTER travel from loading to unloading areas
EASIER—truck movement from docks to storage is unattended
ECONOMICAL—more material handled per man hour
LIVE STORAGE on trucks reduces required dock area
EFFICIENT WAREHOUSING—more uniform flow, better inventory control, fewer personnel

In an existing 360,000 square foot warehouse, how do you modernize the handling of 40,000 different hardware items stored on three floors? Here's how a Webb Tow-Conveyor system efficiently answered the problem for the Stratton Warren Hardware Company in Memphis, Tennessee.

Two overhead tow-conveyor lines were installed to provide continuous "loop" type travel of warehouse trucks. Both conveyors travel at a constant speed of 85 F.P.M. and tow-trucks can be attached on 16-foot centers. Thus, the entire system has a capacity of 255 tow-trucks carrying an average load of 600 pounds each.

Conveyor number one (see schematic drawing above) serves "pick-up and city delivery", shipping dock, basement area and first floor warehousing area. Note at top of two 9° ramps connecting basement to first floor, conveyor one is in close proximity to conveyor two. This permits quick and easy transfer of tow-trucks from one conveyor line to the other. From the first floor, conveyor number two tows trucks up and down a 12° ramp and around the second floor. Fixed travel pattern of tow-trucks was established to provide maximum convenience and efficient handling in all areas of warehouse.

To assure controlled safe towing of trucks up and down the ramps, rigid telescoping masts were attached to each tow-truck and a specially designed engagement box was mounted to bottom of conveyor trolleys. The upper end of the mast slides into the trolley box and is automatically locked in place—a simple manual pull on box release lever disengages the mast. The telescope construction of the mast permits lowering for entrance into highway trucks. Convenience and efficiency are evidenced everywhere in this modern handling system.

Mr. Leslie M. Stratton, President, says: "The conveyor works perfectly and we are well satisfied. My only regret is that we did not have the conveyor installed ten years ago."

JERVIS B. WEBB COMPANY
8945 ALPINE AVENUE • DETROIT 4, MICHIGAN
SPECIALISTS IN CUSTOM CONVEYOR SYSTEMS

Circle 688 on Page 35

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems.

For detailed information and literature, use card page 35.

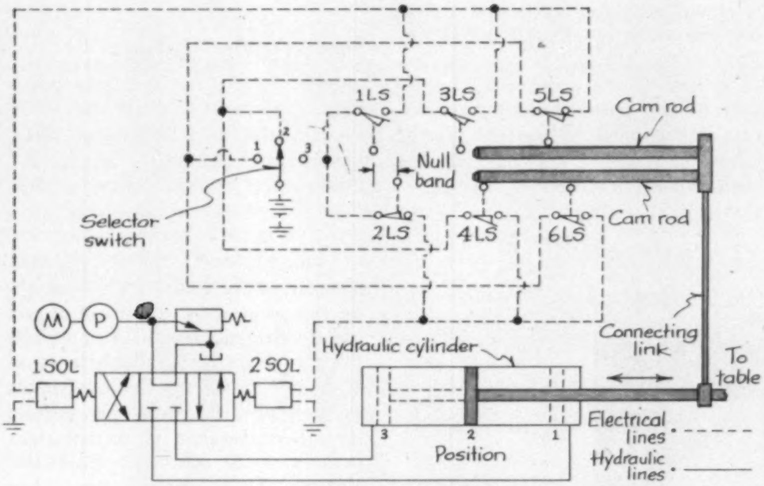
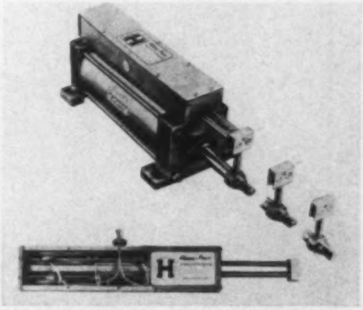


Diagram illustrates the use of the positioner in controlling a hydraulic cylinder with three stopping positions. The circuit provides means for moving the piston of the cylinder to the selected stopping position and then for correcting overshoot in either direction so that the piston stops at the desired position with repeatable accuracy.



Model PR2A positioner is equipped with two cam rods which trip pairs of limit switches as the rods slide back and forth inside the extruded aluminum housing. The unit is shown installed on a pneumatic cylinder and will position a 4-inch diameter plug valve to plus or minus 0.015 inch. The positioner can also be installed on hydraulic cylinders or can be used to control motor-gear reducers connected to machine tool tables.

Multiple Servo Positioning Control

ELECTRICAL - MECHANICAL servo device, designated Model PR2A Hanna-Powr Positioner, is designed to automatically position air and hydraulic cylinders at one or more preset points with repeatable accuracy upon receiving a signal from a selector switch. Developed by **Hanna Engineering Works,** Dept. PR-26, 1765 Elston Ave., Chicago 22, Ill., the positioner can be used to operate pipeline valves from remote control stations; to position rotary or reciprocating worktables for machine tools; to open and close dampers and louvers, doors, and hopper gates; and to switch gates for selective discharge from conveyors.

The positioner is available in various sizes up to a stroke length of 7 2/3 feet and in cylinder bores from 1½ inches to 8 inches for hydraulic cylinders and to 14 inches for pneumatic cylinders. Up to 14 different positioning stops per foot can be used with positional accuracy depending upon mass and velocity of load, friction between base and load, and friction of cylinder. For example, a 3-inch air cylinder will position a 4-inch diameter plug valve to plus or minus 0.015 inch reliably. An 8-inch air cylinder will position a 4000-pound block of cast iron, sliding on a rough concrete surface, with a maximum positioning accuracy of plus or minus ¾-inch at velocities of 1 inch per second.

Hydraulic positioning can be done with greater accuracy and is suitable for holding vertical loads or loads with extraneous forces applied to them. It is possible to obtain hydraulic positioning to within plus or minus 0.010 inch with loads of 25,000 pounds moving on rollers at velocities of up to 2 feet per second. Accuracies of plus or minus 0.005 inch are possible under suitable operating conditions.

The positioner is equipped with two cam rods which are rigidly connected to the actuating arm of the mechanism being controlled. The cam rods slide back and forth inside channel grooves in an extruded aluminum housing and actuate pairs of limit switches. One of the limit switches in each pair is normally closed, and the other is normally open. The space between the actuators of each switch pair in the direction of motion provides a null band.

The diagram shows a positioner installation for controlling three positions of a hydraulic cylinder. The electrical and hydraulic circuits of the diagram are shown with the piston of the cylinder stopped in Position 2. To move the piston (and work load) to Position 3, the selector is switched to Contact 3, energizing Solenoid 2 of the hydraulic valve through limit switch 2*LS*. This action causes the spool of the valve to shift, admitting fluid to the rod end of the hydraulic cylinder and causing the piston to move toward Position 3. When the lower cam rod contracts 2*LS*, it causes the switch to open, de-energizing Solenoid 2 and allowing the valve to spring-return to its neutral position. This stops the fluid flow to the cylinder, allowing the ends of the cam rods to stop in the null band between switches 1*LS* and 2*LS*. If the mass and velocity of the load causes the rods to overshoot the null band, then 1*LS* is closed by the upper cam rod, energizing Solenoid 1 and causing the valve spool to shift and feed oil to the blind end of the cylinder. This action causes the piston movement to reverse until the cam rod rides off 1*LS*, neutralizing the hydraulic circuit again. Overshoot in this direction can be again corrected by 2*LS* and Solenoid 2.

To move the piston to Position 1, the selector is switched to Contact 1, energizing Solenoid 1 through limit switch 5*LS*. This action causes the valve to shift, admitting fluid to the blind end of the cylinder. When the actuator of 5*LS* rides off the upper cam rod, the hydraulic circuit is neutralized. Overshoot is corrected by the lower cam rod allowing 6*LS* to close, energizing Solenoid 2, shifting the valve spool, and admitting fluid to the rod end of the cylinder to reverse piston movement. Location of the position limit switches can be changed by loosening two adjustment screws and moving the pairs of limit switches to new positions.

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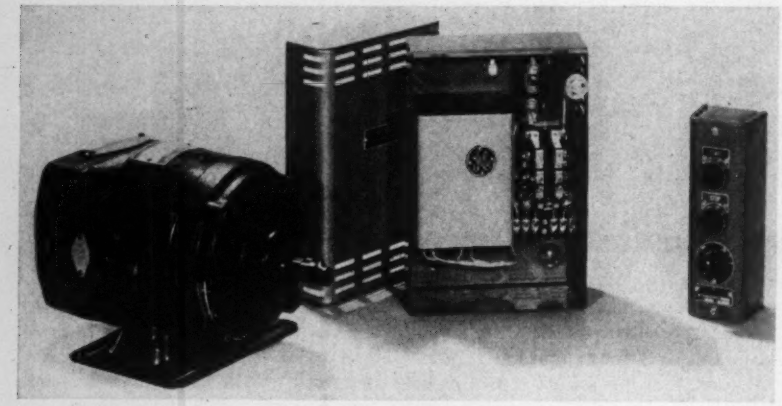

Adjustable Speed Drive

Available in standard ratings from 1/20 to ¾ hp, static adjustable speed drive has a standard speed range of 8:1. For intermittent duty it may be operated over a much wider range. Designed for operation on a 115 v, 50/60 cycle, single phase power supply, the Statotrol drive may be operated from any standard voltage with a suitable transformer. Basic control module of the unit combines a silicon-controlled rectifier and simplified encapsulated circuitry. This control module, along with a suitable potentiometer and disconnecting means, constitutes a complete control for starting, stopping, and adjusting the speed of a dc motor. The silicon-controlled rectifier is used for converting alternating current to controlled direct current for smooth, stepless operation of a fractional horsepower motor. Use of this solid-state device gives the drive instant starting ability, since it eliminates the warm-up period necessary for the filaments of tube types. It also makes the drive highly efficient by elimination of energy required to maintain the cathode of an ordinary tube at rated temperature. This drive is capable of operating under extreme environmental conditions with a minimum of maintenance. It is shock and vibration resistant. **General Electric Co.,** Schenectady 5, N. Y.

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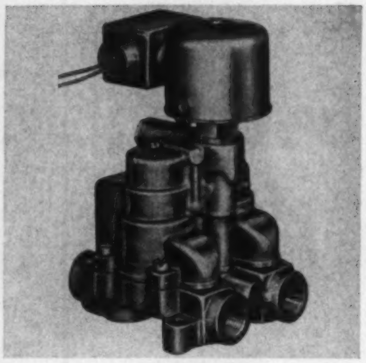

Pneumatic Valves

Line of three and four-way pneumatic valves are rated for 1000 cycles per minute continuous duty. Designated Crescent "Mach 2," these valves feature design innovations that lengthen coil life and improve valve performance through use of an extremely short solenoid plunger stroke (3/32 inch) and reduction of friction in both pilot and main valve members. Rated at 150 psi, the valves are available in ¼ to ¾-inch pipe sizes. Cycling speeds as high as 2100 cycles per minute have been reached for intermittent periods of 20 minutes. **Barksdale Valves,** 5125 Alcoa Ave., Los Angeles 58, Calif.

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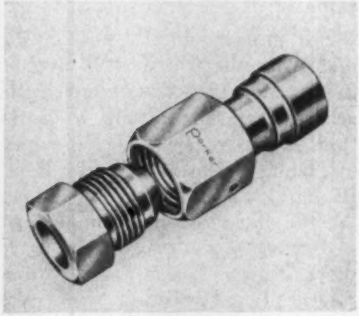
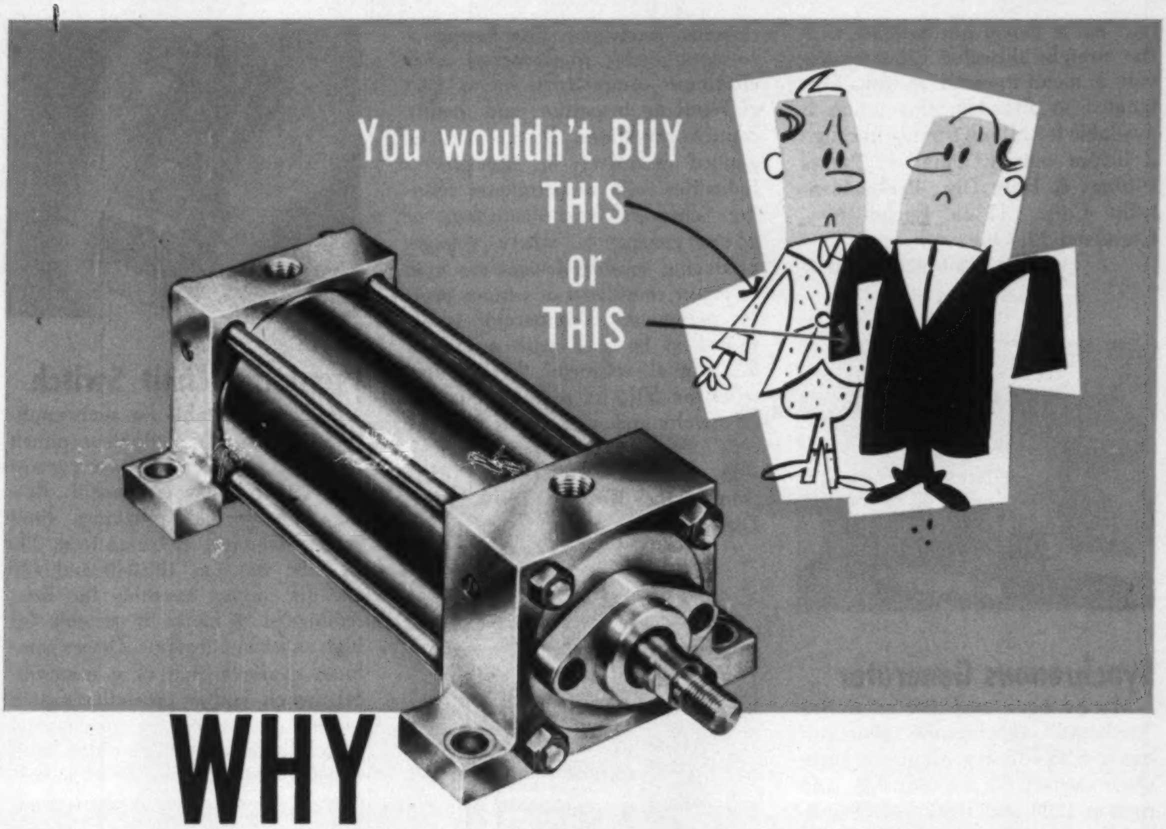


Threaded Union

This fitting, equipped with a prepositioned brazing ring inside the socket, provides a semipermanent, brazed tubing joint to assure nonleak connections for high pressure and other critical service. It consists of two parts, each of which has a socket for brazing to the tube. One part has the SAE hydraulic 37-degree flare cone while the other



WHY SETTLE for a Cylinder

THAT ISN'T EXACTLY WHAT YOU WANT BECAUSE IT HAPPENS TO BE IN STOCK?

You'll be glad to know that Hanna Cylinders, custom built to your exact requirements of bore, stroke, mounting, and rod end can be shipped in a time comparable to stock cylinders.

There are important advantages to you in this Hanna service:

You get the exact diameter, stroke, mounting, and rod end you want—there's no need to accept a larger or smaller bore or substitute mounting style.

Hanna cylinders are as economically priced as most "stock" cylinders and are a far better value in the long run.

Hanna can deliver several cylinders as promptly as one or two because we are not limited to a fixed stock.

With Hanna Service emphasis is placed on "When do you need it?" You'll find we can ship according to your schedule.

For top quality, custom built cylinders at prices and deliveries competitive to less suitable "stock" cylinders, call us or your nearby Hanna Representative. He is listed in the Yellow Pages under "Cylinders" and in Thomas' Directory.

WRITE FOR NEW CATALOG #1000-A

It will give you details on Hanna-Powr Cylinders and Hanna-Flo Valves.

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CYLINDERS
VALVES

Hanna Engineering Works

60 Years' Experience In Building The Finest Cylinders, Valves and Other Hydraulic and Pneumatic Equipment

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part has a swivel nut to mate with the straight threaded cone to provide a metal-to-metal seating. Designated as Braz-lok, this union is available for tubing from 1/4 through 2 inches outside diameter. **Parker Fittings & Hose Div., Parker-Hannifin Corp.**, 17325 Euclid Ave., Cleveland 12, Ohio.

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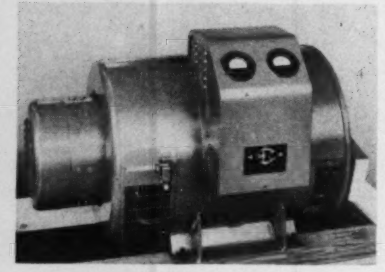
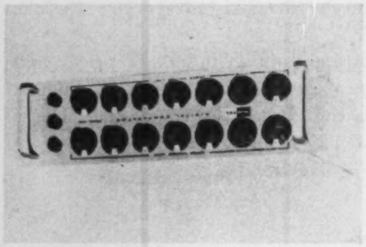


Synchronous Generator

Magnetic amplifier controlled "packaged" synchronous generator has a 6.25-187 kva, single or three phase output, 80 per cent P.F., and runs at 1200 and 1800 rpm. Standard voltages, 120/208, 240/416, 480 volts (12 leads brought out for selection of voltage), are available at a 60 cycle frequency. Brushless exciter unit features all welded steel frame, and simple, one-knob voltage control. It has a ±2 per cent voltage regulation. **Electric Machinery Mfg. Co.**, Minneapolis 13, Minn.

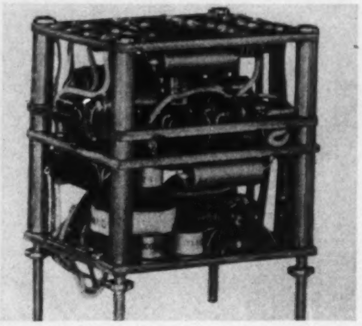
Circle 430 on Page 35



Digital Comparator

Unit has dynamic range of 0.1 mv to 1000 volts, making it applicable to many of the go-no-go type problems encountered in industrial systems. It indicates whether an applied input voltage is over, between, or below preset tolerance limits. Model 465 can be used to operate lights, alarms, or relay closures, production line testing of resistors, diodes, transistors or other electronic components, or as part of receiving inspection and quality control operations. It can also be applied extensively in the process industries such as petroleum refining, chemical manufacturing, or power generation, where voltage-producing sensing devices are used to detect conditions of various process parameters. Comparator is designed to be used with a 501 or 502 digital voltmeter. When used with the 501, its resolution is 100 microvolts and accuracy is 0.01 per cent ±1 digit (of voltmeter reading). **Kin Tel Div., Cohu Electronics**, 5725 Kearny Villa Rd., San Diego, Calif.

Circle 431 on Page 35



Controllers & Amplifiers

Line of solid state, modular, silicon controlled rectifier phase controllers and servo amplifiers has been developed for such applications as servo motor controls used in the industrial process and machine tool fields, dc motor controls, welding equipment, degaussing systems, temperature controls, and light and brightness controls. Basic modules using silicon controlled rectifiers can be combined to provide optimum design for practically any power control application from watts to kilowatts. Input signals can be 400 cycle ac or 60 cycle ac or dc. Variations of the basic modules number about 50 and can be combined to form thousands of different control amplifiers for a wide variety of applications. Unit response time is 1/2 cycle maximum. **General Electronic Control Inc.**, Application Engineering Dept., 1015 S. Sixth St., Minneapolis 4, Minn.

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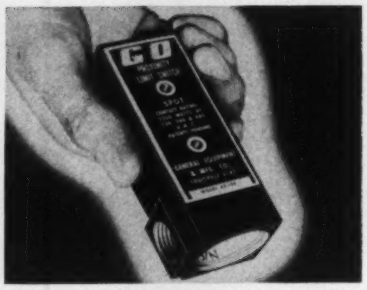

Proximity Limit Switch

Switch is suitable for such applications as forging equipment, punch presses, lift hoists, conveyor transfers, and foundry equipment. Rating of this *Go* proximity limit switch has been increased from 250 to 1250 watts at 120,240 and 480 vac. Its contact assembly has been redesigned to make it suitable for high shock applications. Device combines characteristics of a mechanical switch and a proximity switch system. It is like a mechanical switch because it is provided with a self-contained set of contacts that operate in response to the actuating means provided. It is like the conventional proximity switch system since it operates completely without physical contact with its actuating means. **General Equipment and Mfg. Co.**, Dept. 8 TP, 116 S. Campbell St., Louisville 6, Ky.

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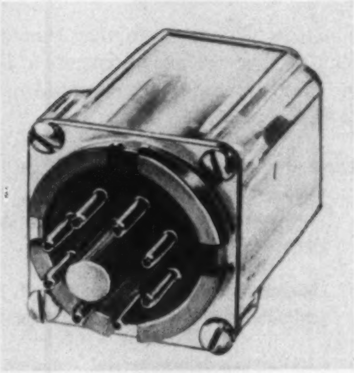
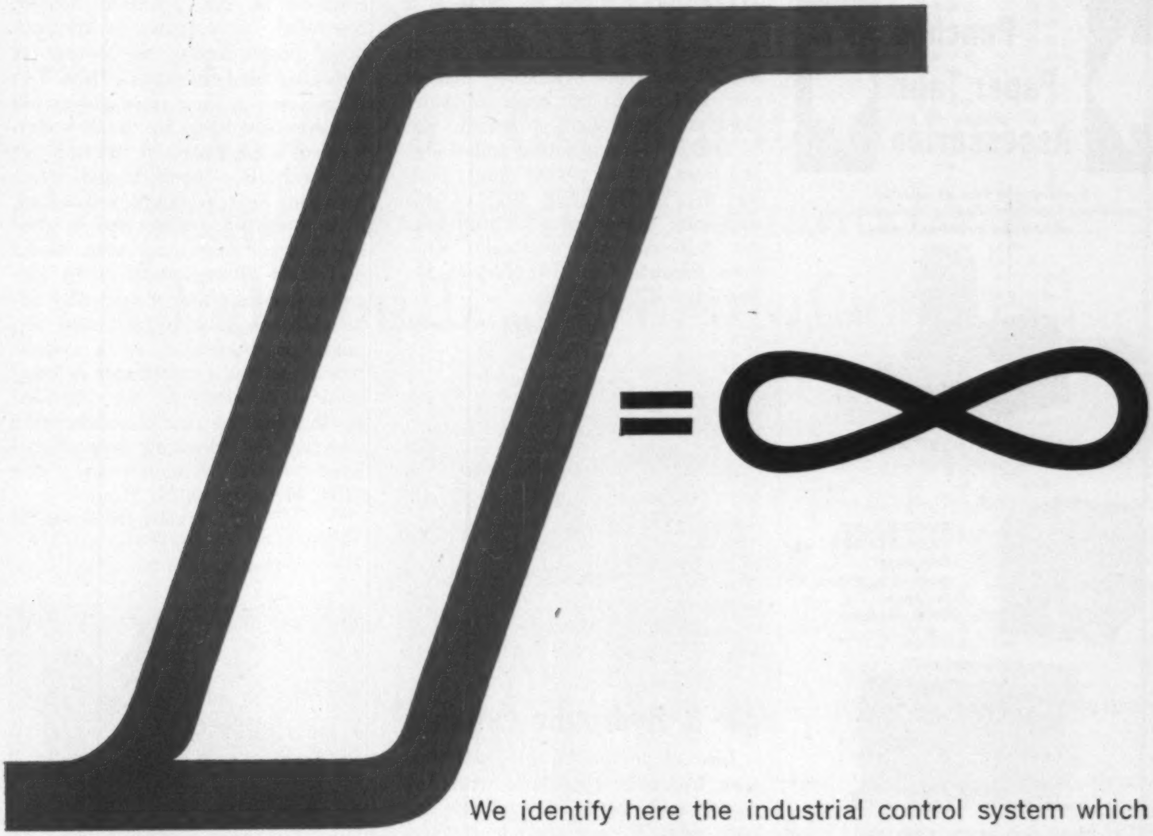


Plug-In Relays

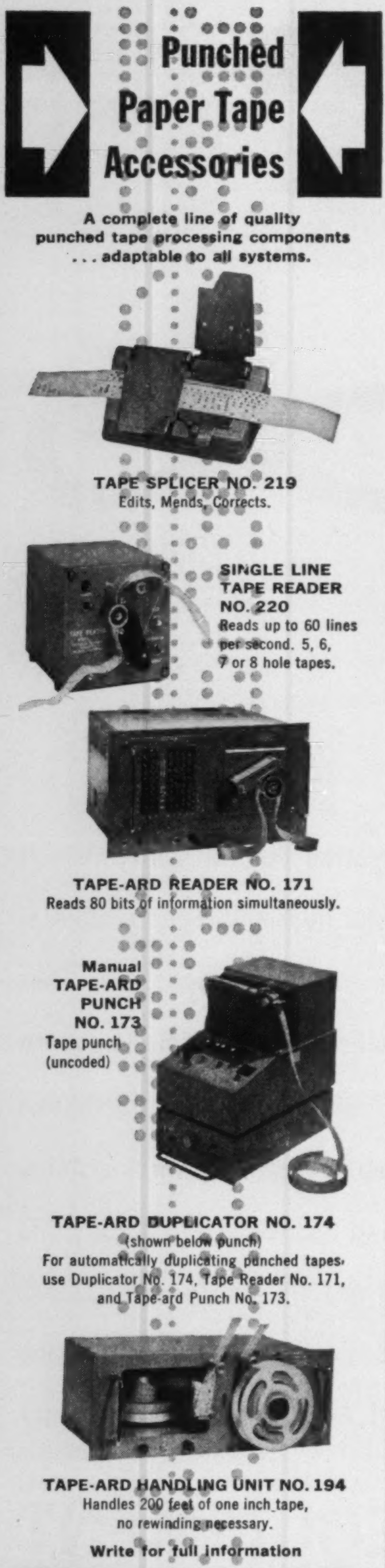
Line of multipole plug-in sensitive relays with polystyrene covers features self-wiping contacts with operating power as low as 25 milliwatts per pole—dc operation only. Models 5D2C, DPDT, and 5D3C,



We identify here the industrial control system which will operate through an endless number of cycles without need for human direction, maintenance or servicing. The symbol for infinity in the equation shown above is obvious. The other symbol, the hysteresis loop defines the system as *magnetic* static control. The word "static" is used because there are no moving parts. Thus, under normal operating conditions the system never wears out. Customers have come to us for magnetic static control systems which are in use today from the automated lines of New England textile mills to automobile assembly lines in Detroit, to the steel mills of the Argentine. If you, like they, wish to learn what operational statistics and costs *could* be by using magnetic static control for long life and dependability, will you please write us? Magnetics Inc., Dept. A-83, Butler, Pennsylvania.

INDUSTRIAL CONTROL EQUIPMENT

MAGNETICS inc. ®


Punched Paper Tape Accessories

A complete line of quality punched tape processing components . . . adaptable to all systems.

TAPE SPLICER NO. 219
Edits, Mends, Corrects.

SINGLE LINE TAPE READER NO. 220
Reads up to 60 lines per second. 5, 6, 7 or 8 hole tapes.

TAPE-ARD READER NO. 171
Reads 80 bits of information simultaneously.

Manual TAPE-ARD PUNCH NO. 173
Tape punch (uncoded)

TAPE-ARD DUPLICATOR NO. 174
(shown below punch)
For automatically duplicating punched tapes, use Duplicator No. 174, Tape Reader No. 171, and Tape-ard Punch No. 173.

TAPE-ARD HANDLING UNIT NO. 194
Handles 200 feet of one inch tape, no rewinding necessary.

Write for full information

CALIFORNIA TECHNICAL INDUSTRIES
DIVISION OF TEXTRON INC.
BELMONT 7, CALIFORNIA

Circle 691 on Page 35

3PDT relay contacts are rated at 5 ampere 28 volt dc and 115 volt ac. A variety of coil resistances up to 20,000 ohms are available. Relays are available in the open construction or hermetically sealed, up to 4PDT. Five standard coils ranging from 500 to 10,000 ohms, both for the DPDT and 3PDT—with operating power of 100 milliwatts per pole—are also available. **Kurman Electric Co.**, 191 Newel St., Brooklyn 22, N. Y.

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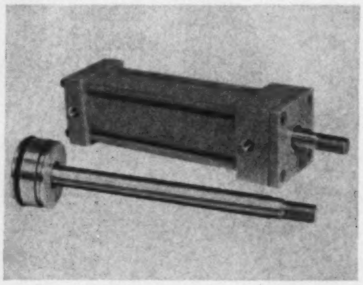
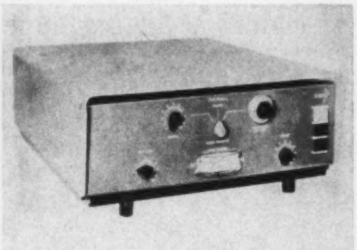


Air & Hydraulic Cylinder

Line of pneumatic and low pressure hydraulic cylinders, with $1\frac{1}{8}$ to $3\frac{1}{2}$-inch bores, is available for both original equipment or replacement purposes. Features include one-piece aluminum piston; hard chrome plated piston rod; aluminum end caps; seamless brass tube; block vee seals and wiper on rod and piston; and adjustable cushions either end. Cylinder is available in flush, foot, front and rear flange, clevis, or pivot mountings. **Mo-Bar Hydraulics Co.**, Crystal Lake, Ill.

Circle 435 on Page 35



Furnace Controller

Controlling the temperature of electricically heated materials by smoothly and precisely regulating input power up to 24 kva is the function of this precision furnace controller. It operates by continuously proportioning the output of two air-cooled thyratrons from 3 to 95 per cent of their rated power (40 amperes at voltages up to 600 volts). Typical applications of the unit are in controlling furnaces and ovens used in heat treating, enameling, baking, drying, curing, and in glass smelters and laboratory tests. Model SPY 5064 Thermac uses for its control reference either a manually adjustable, temperature calibrated, setpoint potentiometer, or a voltage from a remote programmer or computer. Adjustments are provided for limiting the rate of temperature rise and for adjusting proportional band width. **Research Inc.**, Box 6164, Minneapolis 24, Minn.

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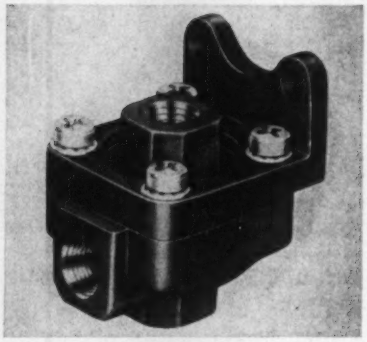


Shuttle Valve

Unit is most commonly used to connect two controlling devices to a single operation. Either of the two controlling devices may control the operation. When one controlling device is actuated the inoperative controlling device is sealed from the line. The valve selects and directs the flow of air from one or the other of the two controlling devices to a common outlet. Only 1 psi pressure differential will seal off the low pressure line and connect the higher pressure line to the outlet. The valve contains only one moving part and has no springs. It weighs six ounces and can be supported by piping alone. Mounting feet are included for installations with vibration or long pipe runs. Available with $\frac{1}{8}$ or $\frac{1}{4}$-inch ports, the valve is suitable for a maximum air pressure of 200 psi. Maximum oper-

What?

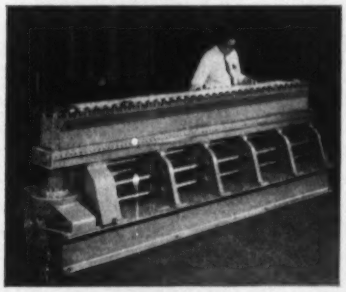
America's finest automatic transfer machines made by a light bulb manufacturer!

Many years ago we discovered that Sylvania specifications for automation equipment were so exacting, we had to make the machines ourselves. Nothing accurate enough was available anywhere, at any price.

For 20 years we have been making this automation machinery to produce our own light bulbs, radio tubes, fine electronics equipment. No one has ever equaled Sylvania automation machinery for accuracy and long-term dependability.

Now these machines are available to outside companies seeking this same extraordinary degree of accuracy.

Ideal for high-speed automatic fabricating, finishing, assembling, indexing, packaging, these machines are available in two general types:



1. Conveyor indexing chassis, exceptional for the extreme accuracy, strength, and versatility of its chain—not made commercially, but by Sylvania itself. Chassis also provides greater tool and driving capacity than other such chassis on the market.

2. Rotary indexing chassis in two sizes and in single and double turret models. Made with unusually great driving and tool capacity. Top of the transmission spider is specially machined for rotary vacuum or pressure valve.

Also, precision indexing transmissions (5 models)

- **Heavy-duty unit** with extra-large cam well and spider diameter for wider range of stops per revolution.
- **Standard unit** features higher cam speeds, a provision to integrally mount rotary vacuum or pressure valves.
- **Universal unit** operates with its output shaft horizontal or vertical. Has wide range of applications.
- **Small universal unit.** Lower silhouette and extra-long input shaft are main features of this extremely durable, accurate transmission.
- **Conveyor unit.** Very rugged, heavy-duty unit designed for conveyors, but easily adaptable for rotary tables, other intermittent motion machines.

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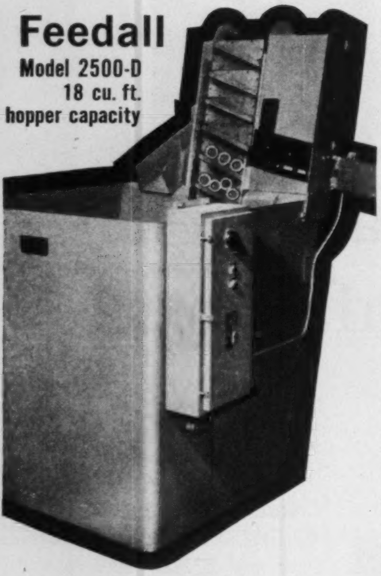
Subsidiary of **GENERAL TELEPHONE & ELECTRONICS**



Feedall
Model 2500-D
18 cu. ft.
hopper capacity

AUTOMATIC
BEARING FEEDER

eliminates hand operations

PROBLEM: Reduce high costs of material handling and manual feed of small bearings parts. Also, provide uniform rate of output with faster production.

RECOMMENDATION: Feedall Model 2500-D, a thoroughly proved, demand-feed machine especially developed for bearing parts, rings, trunnion cups and similar pieces.

RESULTS: Continuous output at desired rate with substantially lower cost per piece.

Why not reduce **your** costs with automated feed on high speed production equipment. Write for details today.

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Designers and builders of automatic feeding devices

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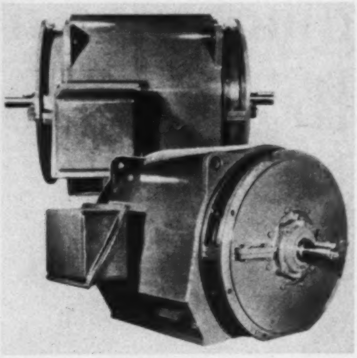
Circle 693 on Page 35

ating temperature is −40 to 160 F. Intermittent operating temperature of 200 F is permissible. **Industrial Products Div., Westinghouse Air Brake Co.,** Wilmerding, Pa.

Circle 437 on Page 35



Pump Motors

Two special electric motors have been built for high pressure pump applications. Each of the mechanically modified units is rated at 350 hp, 1160 rpm, and designed for operation on 3-phase, 60-cycle, 440 volt systems. The motors have shaft extensions on both ends to which pumps can be directly mounted. Completely drip-proof enclosures have ventilating openings so located and shielded as to provide essentially splash-proof protection. Feet are positioned under the overhang of the frame. **Wagner Electric Corp.,** 6400 Plymouth Ave., St. Louis 14, Mo.

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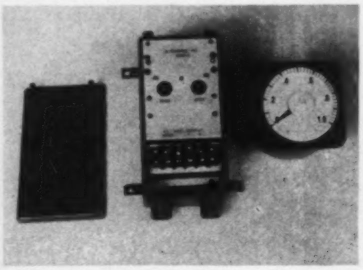

Pressure Transducers

Series of industrial pressure transducers are used to convert fluid pressures into continuous electrical signals for directly driving remotely located milliammeters or direct-writing galvanometers. The units are available in full scale pressure ranges from 0-1.5 inches of water (0-0.05 psi) to 0-5000 psi gage, differential. Absolute ranges from 0-5 psi to 0-5000 psi are also available. The transducers are designed to operate from a standard 115 v ac, 60 cps voltage supply and have optional built-in regulation for 105-130 v ac variation. They are available for use with corrosive or noncorrosive liquids and gases. Units are operational over a temperature range of −65 to 160 F and can be separated from their indicating devices by 5000 feet or more. **Ultradyne Inc.,** P. O. Box 3308, Albuquerque, N. Mex.

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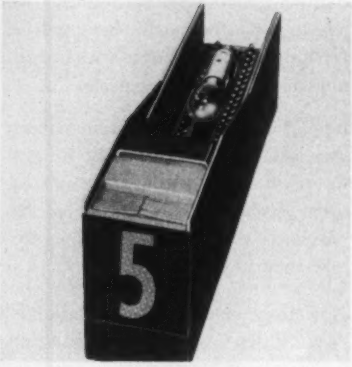

Digital Readout

Designated Slide Plate Readout, this unit eliminates the need for a special decoding device to translate binary information into decimal information. It automatically decodes any BCD code up to six bits into numeric, alphabetic, or special symbol character presentation. It is designed for use with digital computers, control equipment, instruments, and other electronic or electrical test equipment. In addition, it will work directly from teletype machines. The readout provides 16 digits or special characters and operates on a light-interference principle. Operating on low signal power input, it requires only 10 milliwatts of signal power. Features of the unit include check-back and verification circuits as well as memory storage. **Industrial Electronic Engineers Inc.,** 5528 Vineland Ave., North Hollywood, Calif.

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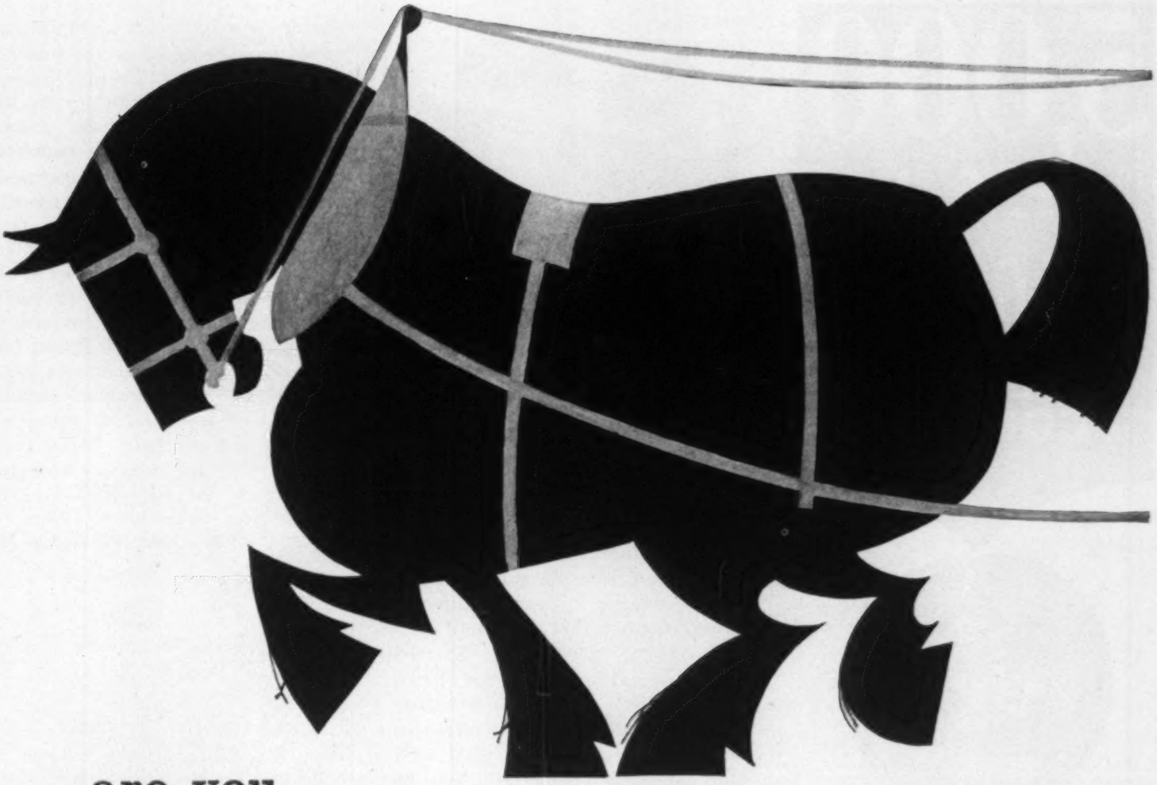
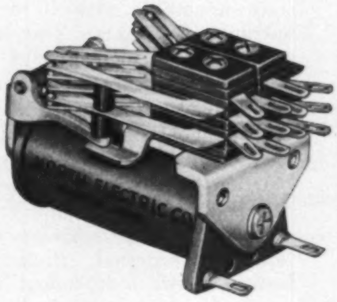


are you using North Electric's Workhorse "E" relay?

Expanded production facilities and increased efficiency in manufacturing methods have enabled North Electric to step up production of "E" relays to provide prompt delivery (at a new low cost, too) to an ever-growing list of steady customers.

If you need a relay that incorporates the inherent proven dependability of a telephone-type relay with minimal spatial requirements, this "little workhorse" from North can be your answer!



GENERAL CHARACTERISTICS:

Light Weight (2½ ozs.)
Compact (Length 2¼"; Width 1⅛"; Height 1¾" max. with 10 springs in either pile-up)
Long Life (over 100 million operations)

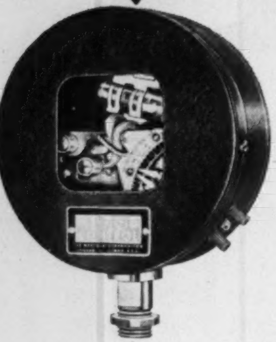
SPECIFICATIONS:

Coil Voltages: Up to 250V DC
Contacts: Independent action twin contact springs
Contact Materials: Palladium, Gold, Platinum
Forms: A to C
Speed: 3 ms. minimum
Residual: Lock Screw (adjustable)—Fixed (nylon flap type)
Time Delay: Available for both operate and release
Coil: Single or Double wound
Mountings: 2 #6-32 Screws on ¾" spacing
Accessories: Dust Cover and Hold Down Bracket

ELECTRONETICS DIVISION
NORTH ELECTRIC COMPANY
121 S. Market St. *Galion, Ohio*

Circle 694 on Page 35

5,000
P. S. I.
MERCOID
PRESSURE
CONTROL



OPERATING
RANGE
500 to 5,000 psi.

TYPES AVAILABLE
DXA-21
minimum differential 450 psi.
DXA-521
minimum differential 200 psi.
DXS-221
minimum differential 150 psi.

EXTERNAL ADJUSTMENTS

SEALED MERCURY CONTACT

VISIBLE ON-OFF CIRCUIT

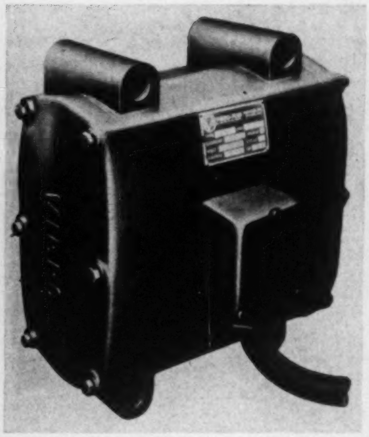
VISIBLE CALIBRATED DIAL

Available in three case styles;
General Purpose
Weather-Proof
Explosion-Proof

WRITE FOR BULLETIN O-21

THE MERCOID CORPORATION
4201 Belmont Ave., Chicago 41, Ill.

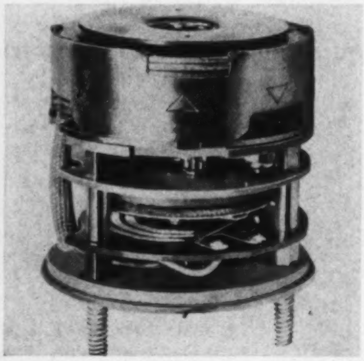
Circle 695 on Page 35



Electric Vibrator

Device is suitable for applications such as vibrating tables, feeders, screens, chutes, or for problems best solved through the use of directed force. Model ET-31 dual shaft electric vibrator develops a directed force vector through the use of two eccentrically weighted armature shafts geared together to rotate in opposite directions. Equipped with four adjustable eccentrics, it can be set to produce impacts from 760 to 2200 lb at 3600 vibrations per minute. Available for operation on 3-phase, 60-cycles, 220 or 440 volt, it is normally supplied with a starter box. Special mounting brackets are available. **Vibro-Plus Products Inc.**, Stanhope, N. J.

Circle 441 on Page 35



Stepping Devices

Line of compact stepping devices, Series 18400, can perform high-speed sequencing, pulse control, and switching functions. The line includes rotary stepping switches, pulse dividers, and precision sequencers capable in many cases of replacing conventional solenoid or relay-actuated units. The circuit rotary stepper switches contain up to 30 positions on a single deck. Each pulse cycle advances these switches one position. They can be operated continuously or at random intervals to produce up to 2400 steps per minute at 24 volts dc. Precision gated stepping switches can serve as pulse dividers for random or variable pulse sources or as frequency dividers when the pulse source is constant. Precision sequencers perform single or multiple switch closures with an accuracy equal to the pulse source itself. They can be used in pulse memory storage systems. **A. W. Haydon Co.**, 232 N. Elm St., Waterbury, Conn.

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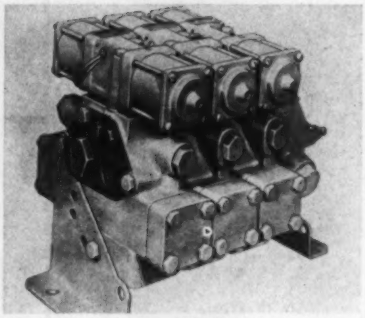

Stackable Valve

Solenoid operation and extreme adaptability are application features of this 25 gpm four-way separate segment valve. This valve is available in series or parallel circuit stack assemblies with 10 or more operating segments. The stacked assemblies can include relief valves and pilot pressure control valves. The valve can be furnished for ac or dc solenoid, remote pilot, manual, or mechanical control. Any combination of the control variations can be combined in one multiple valve stack. Pilot pressures can be internal or external. Built-in flow feature allows independent adjustment of cylinder speeds in either direction. Unit can be remotely operated and has a continuous duty pressure rating of 3000 psi. It can, however, tolerate intermittent pressures to 5000 psi. Valve has a 7/8-inch straight thread porting for

1001 CYLINDERS
TO DELIVER
QUALITY PERFORMANCE
WHEREVER REQUIRED

Select from full lines to operate and control a single OEM product ... or a plant's entire production line!

Schrader means quality . . . in complete lines of double-acting and single-acting cylinders in a variety of sizes . . . including JIC and miniature cylinders. Schrader Air Cylinders . . . as well as complete lines of Valves and Accessories . . . are at work on many OEM products and in thousands of plants performing countless jobs. Your Schrader Distributor is fully stocked . . . staffed with experts to help you solve any air circuitry problem.

Schrader
AIR
CONTROL
PRODUCTS

The complete range of sizes and types of air circuitry products is stocked and cataloged by your Schrader distributor. Consult the yellow pages or write Schrader.

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A. SCHRADER'S SON
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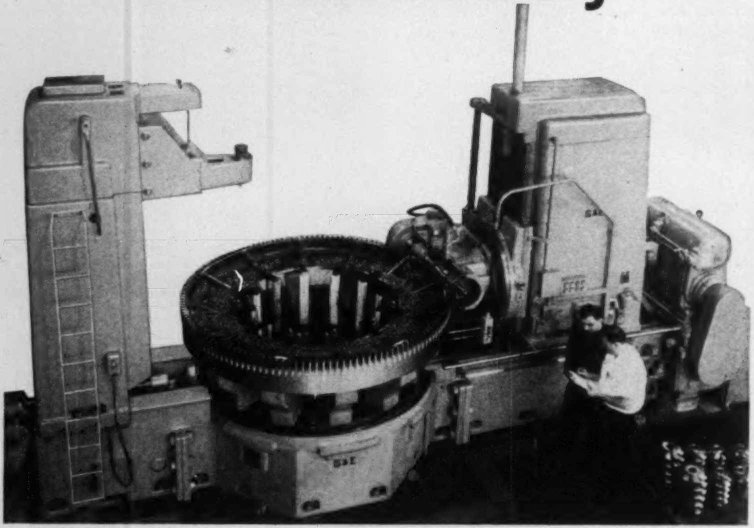
QUALITY AIR CONTROL PRODUCTS

Circle 696 on Page 35

New Production Capacity
For Fast Delivery



Large Generated Gears

SPUR • HERRINGBONE • HELICAL

for a wide range of industrial applications

Gears which must operate smoothly and without vibration at higher speeds and under greater loads must correspondingly be more accurate in tooth profile and spacing.

H & S Generated Gears answer these demands.

Offering the same high-quality standards which characterize the complete H & S Gear line, production capacities for large generated Spur, Helical and Hobbed-Herringbone Gears are now available in the following dimensions:

Up to 80″ outside diameter at 1 DP
Up to 90″ outside diameter at 1¼ DP
Up to 100″ outside diameter at 1½ DP
Up to 125″ outside diameter at 2 DP
Face widths up to 42″, depending on helix angle

Send your specifications, or let our technical staff make recommendations. H & S specializes in fast production of quality industrial Gearing and Speed Reducers to meet your custom requirements.

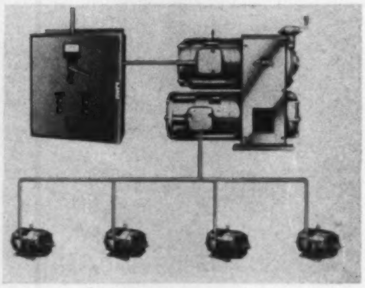
Write for Catalog FLB-60

The HORSBURGH & SCOTT CO.
5112 Hamilton Avenue • Cleveland 14, Ohio

Circle 697 on Page 35

7/8 inch OD tubing. **Mobile Div., Racine Hydraulics & Machinery Inc.**, 2000 Albert St., Racine, Wis.

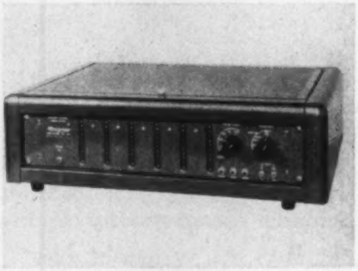
Circle 443 on Page 35



Synchronous Range Drive

Integrated drive system, designated Syncro-Range Drive, consists of an adjustable frequency power supply, one or more Syncro-Spede drive motors, and a control panel. Sizes range from 2 to 15 hp. This drive is designed for operation of multiunit conveyors, textile or paper printing or finishing; synthetic fiber spinning, drawing or twisting; metal run-out tables; and other similar continuous process machines which require application of power at a number of points on the machine. **Louis Allis Co.**, 427 E. Stewart St., Milwaukee 1, Wis.

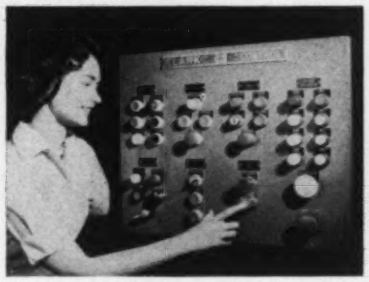
Circle 444 on Page 35



Printing Scaler

Device is designed especially for use in systems where high-speed and/or automatic operation is indicated such as in x-ray diffraction counting systems. It features 15 preset counts from 10 to 500,000 counts and is also operable in preset time and manual modes. Model N-276 printing scaler is used in combination with a Model N-803 printing timer. Many different modes of operation are possible, with print-out of counts and/or time and automatic recycling available to the user. The scaler has a pulse pair resolution of better than 1 microsecond, a repetition rate of 1 megacycle, and a display of 6 electronic decades. Sensitivity is ±4 volts peak minimum. **Hamner Electronics Inc.**, P. O. Box 531, Princeton, N. J.

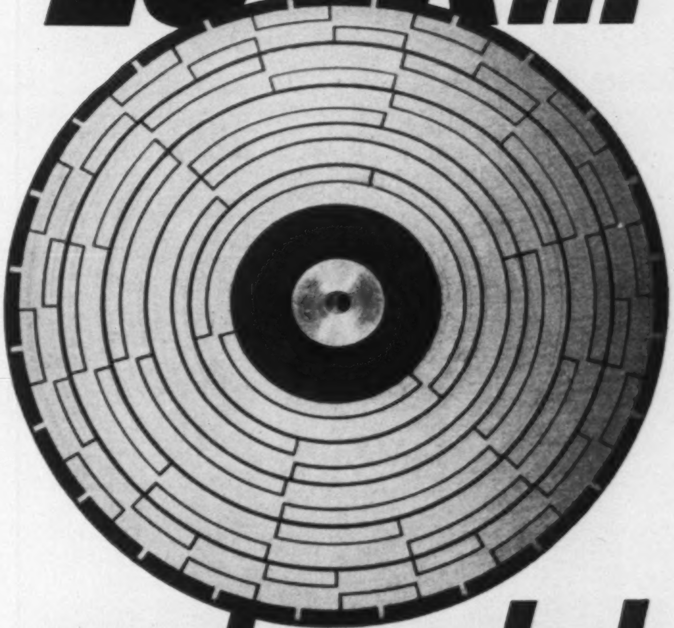
Circle 445 on Page 35



Push-Button Stations

Heavy duty push-button stations and control units are available in three types. Each line includes push-button units, selector switch units, standard pilot lights, and push-to-test pilot lights or lighted pushbuttons. Types 100-HO and 100-H electrical control units are available in the following separate, but related lines: 1. Type HO, oil-tight, one-hole (panel) or base mounted. Panel mounted applications include oiltight flush plates for operator's panels and benchboards. Base mounted units are used in oiltight surface mounted enclosures. 2. Type H, NEMA 1, general purpose, one-hole (panel-mounted) is used for flush plates, operator's panels, and benchboards. 3. Type H, NEMA 1, general purpose, base mounted is used for surface mounted enclosures. Design features include interchangeability of many parts between the three lines, choice of 7 American Standard safety colors for both buttons and ferrules, and stationary terminals held solidly to contact blocks. Tandem operation for panel mounting provides unified operation of up to 8 circuits by a single operator. **Clark Controller Co.**, 1146 E. 152nd St., Cleveland 10, Ohio.

Circle 446 on Page 35



LOOK...

no hands!

This printed circuit disc is the "face" of a clock that tells time in digital code

...or any code your computer, control system, or data processing device needs to keep it properly in touch with the world of real time.—A. W. Haydon is a company of infinite variation when it comes to such analog-to-digital converters, or "binary encoders". Time periods range from seconds to weeks. Sizes range from miniature to large. They come sealed, enclosed or open, with AC, DC, or pulse drive, and with an imposing variety of accessory equipment.—The model shown is for commerical use. It provides a discrete signal for each two-minute interval over a 28-day period. It is used, among other places, in an automatic parking lot ticket computing system.— This and several other time code generators are described in Technical Brochure SP9-2. It's yours for the asking. Similar solid-state devices can be supplied by our Culver City, Calif., facility.

THE AW HAYDON COMPANY

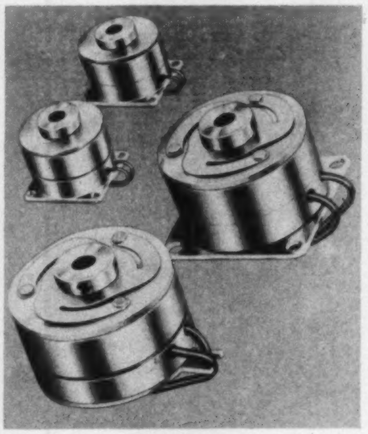
269 North Elm Street, Waterbury 20, Connecticut

Circle 698 on Page 35

Pressure Meter

Device is used in either static or dynamic pressure measuring applications. Consisting of up to four pressure sensors and an electronic read-out unit, Model 689 dynamic pressure meter can be used to measure and read-out individual pressures, pressure differentials, or any arithmetic combination of up to four pressures. Separate plug-in units provide easy adaptation of any strain-gage type pressure sensor to the instrument. Each individual plug-in unit contains balance, sensitivity, load, and calibration circuitry for its associated transducer plus an on-off control for each channel. Output terminals are provided for external recording of the signal. A range switch is used to select ranges of 0-300, 0-1000, and 0-3000 psi. **American Measurement & Control Inc., Subsidiary, CompuDyne Corp.,** 240 Calvary St., Waltham 54, Mass.

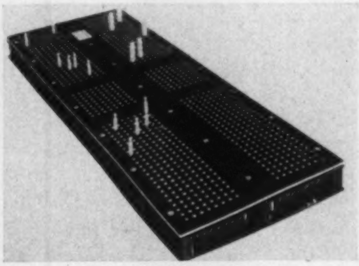
Circle 447 on Page 35



Brakes and Clutches

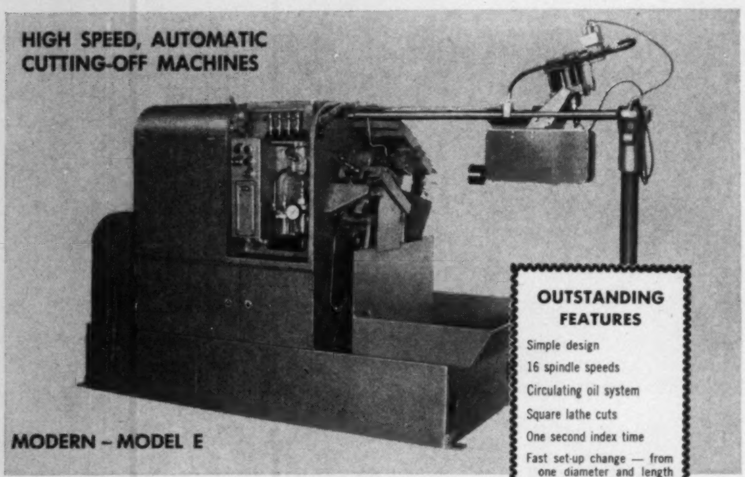
Line of fractional horsepower electric brakes and clutches have been developed to provide a high degree of torque per unit size. They are available in two sizes: 0.875-inch diameter with 2 lb-inch torque, and 1.725-inch diameter with 10 lb-inch torque. The devices are designed to operate on 28 volts or 90 volts standard. Control units are available. **Haydon Div., General Time Corp.,** 245 E. Elm St., Torrington, Conn.

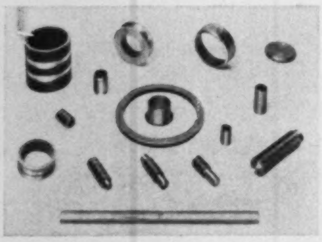
Circle 448 on Page 35

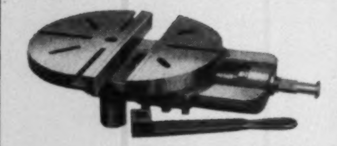


Programming Board

Circuit-switching component interposition device allows instantaneous set up or programming of circuit logic between *X* and *Y* axes of terminations, without the use of patch-cords. At the same time it







HIGH SPEED, AUTOMATIC CUTTING-OFF MACHINES

MODERN – MODEL E

Increase production, lower costs and cut any material that can be turned — bar stock up to 3" O. D. — tubing up to 8" O. D., to lengths from a fraction of an inch to several feet, with micrometer accuracy. Ideal for use with carbide tools.

We also engineer and build machines — using the same bodies and spindles — for such operations as trimming ends of drawn shells and filler caps. Send prints for quotes.

OUTSTANDING FEATURES

- Simple design
- 16 spindle speeds
- Circulating oil system
- Square lathe cuts
- One second index time
- Fast set-up change — from one diameter and length to another. Any tool can be changed without disturbing others.
- All cams, adjustments and working parts for cross slide are outside for quick, easy adjustment.
- Chip pan slides out, for easy dumping.
- Power, speed and rigidity for cast alloy and carbide blades.
- Special spindle bearing takes all collet thrust. No thrust on main taper roller spindle bearings.

Catalog and production figures mailed on request.

We can furnish special tooling to meet your requirements — to cut-off, form, groove, flange and chamfer in a single operation, at a high rate of speed. Send prints.

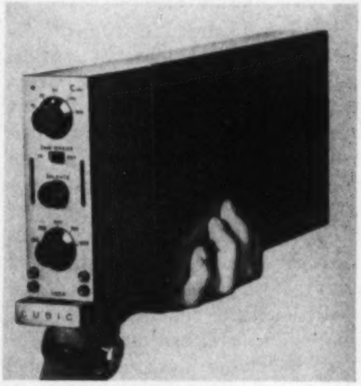
MODERN MACHINE TOOL COMPANY
2005 Losey Street • Jackson, Michigan

FREE TRIAL OFFER. Safe, positive, fast set-ups. The Modern Safety Drill Table handles odd, irregular shapes without V-blocks, clamps or parallels. Ideal for maintenance work. Guaranteed to save its cost in labor alone every 6 months. Sizes from 8" to 27½" dia. Try it at our expense. No obligation.

Circle 699 on Page 35

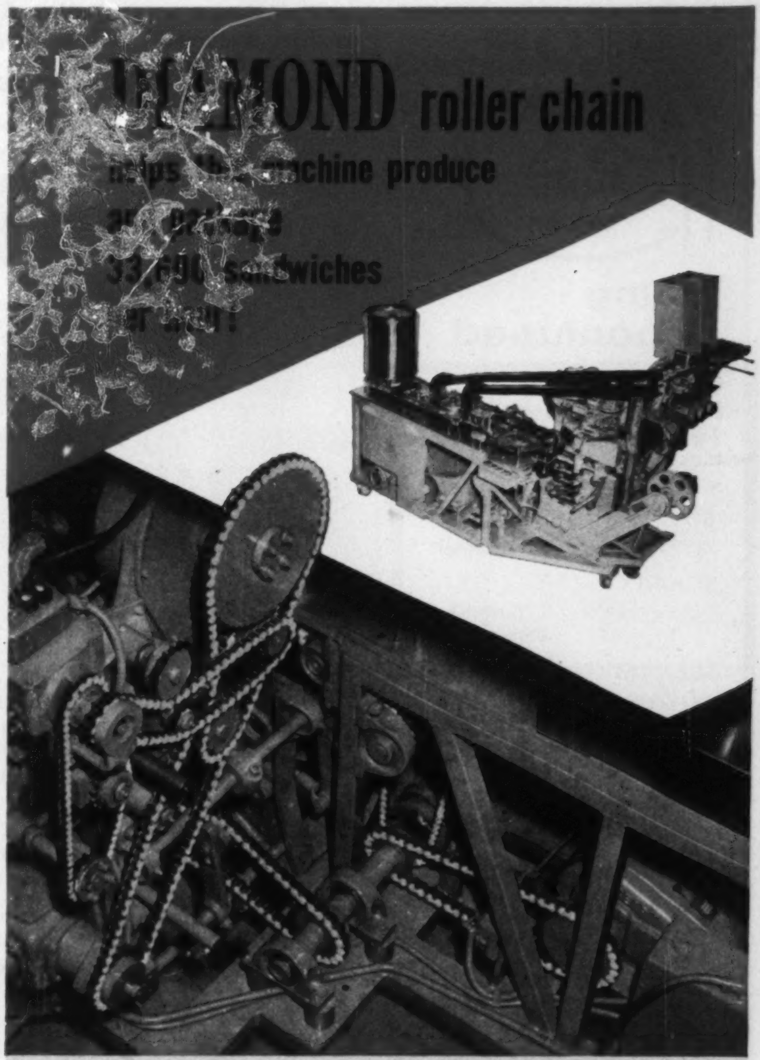
permits interposition of diodes, or other miniature electronic components, between any *X* and *Y* termination. Designated Sealectoboard, the unit can be used to program computers or other electronic assemblies, for the easy replacement of diodes or other components, for circuit characteristic changes, multiple-point switching, etc. It is available with gold-plated contact strips to meet the needs of specialized applications requiring extremely low contact resistance over long periods of time. Standard programming boards incorporate silver-plated contacts for usual requirements. The gold-plated model is ideal for use in installations handling extremely small electrical flows such as thermocouple programming. The unit allows for an effective method of centralized trouble-shooting in complex circuit systems. Feature of the board is a Proto-Kit which allows an engineer to program *X* and *Y*-axis functions by merely inserting a shorting pin at the appropriate intersection of the two axes. **Sealectro Corp.**, 610 Fayette Ave., Mamaroneck, N. Y.

Circle 449 on Page 35



DC Amplifier

Device combines the features of three individual units in one package: A differential-input wideband dc amplifier, a bridge balance circuit, and a well regulated strain-gage power supply. In instrumentation applications where a self-contained power supply is not essential, two dc amplifiers can be combined in a single unit, boosting from 8 to 16 the number of amplifiers that can be mounted abreast in a



◆ 560 sandwiches every minute—made, stacked 4 to a package, wrapped and sealed—by The Lynch Corporation / Quality Machine Company combination unit. The secret is perfect synchronization and split-second timing at high operating speed...a typical example of DIAMOND Roller Chain precision performance.

Whatever your application—conveying, timing, synchronization, power transmission—you can rely on dependable, accurate DIAMOND Roller Chain for a long life of low-cost, trouble-free service.

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A Subsidiary of American Steel Foundries
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DIAMOND ROLLER CHAINS ®

Circle 700 on Page 35

STOP

being confused

Our competition has some funny ideas about cable conveyors. Compare these true facts:

	CHAIN	***CABLE***
SPEED	Big problem	No problem
WEIGHT	Whole problem	1/6 of this problem
LUBRICATION	Big problem	No problem
WEAR	Big problem	No problem
PAYLOAD	Less per HP	More per HP

Now, let us prove it!

GO...

... For the multiple Cable-Link benefits detailed in this free brochure. See your nearest Cable-Link distributor, or write the factory.

WHY CABLE?

Manufactured and distributed in the British Commonwealth by Beatty Bros. Ltd., Fergus, Ontario, Canada.

Territories Available

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Dearborn Cable-Link Conveyor

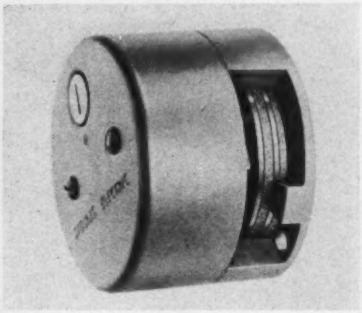
DEARBORN CABLE-LINK CONVEYOR

DEARBORN FABRICATING & ENGINEERING CO.
19440 GLENDALE • DETROIT 23 MICHIGAN

Circle 701 on Page 35

standard 19-inch rack. Model 1100 amplifier features a module that plugs into the chassis of the Cubic Model 1000 Series of dc amplifiers to provide any required gain, fixed or variable, and single-ended or differential input. **Cubic Corp.**, San Diego 11, Calif.

Circle 450 on Page 35



Brake Unit

Spring set, solenoid released brake unit for 40 frame motors has a torque rating of 3 lb ft. Model H 44 is available in ac and dc and with drip-proof enclosure. It is ideally suited for use on small hoists, weighing devices, etc., where greater torque and small size are required. **Stearns Electric Corp.**, 120 N. Broadway, Milwaukee 2, Wis.

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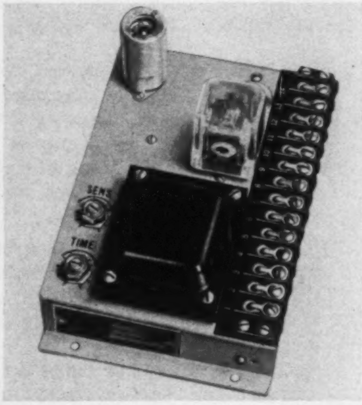

Scanner Relay

A time-response adjustment that permits the light-beam to be interrupted repeatedly, for intervals shorter than the selected delay-time, makes this photoelectric scanner relay suitable for such uses as monitoring the movement of parts through handling systems and providing positive indication when parts fail to feed or when they jam up on a moving conveyor. Delay can be as little as 50 milliseconds or up to 1½ seconds. Various light-source/photocell combinations permit choice of scanning distance and use of direct light or a proximity sensor. This double-pole double-throw plug-in relay handles eight amperes noninductive load at 115 volts ac. Model PE5 connects to any 100-130 volt ac line. **Farmer Electric Products Co. Inc.**, 2300 Washington St., Newton Lower Falls, Mass.

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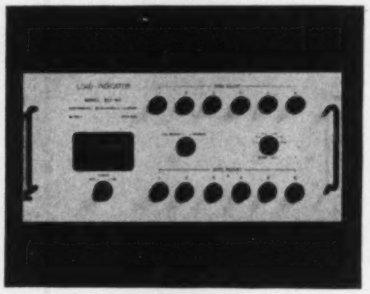
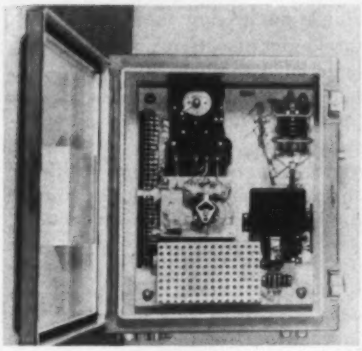


Load Indicator

Load indicating instrument requires only 8¾ inches of vertical rack space to read out six strain gage load cells. Each of the six inputs has its own zero and span controls so that each load cell can be zeroed and its span adjusted independently of the others. Power is applied continuously to load cells so they will always be stabilized and ready to be read. A selector switch permits rapid change from one cell to another during a test. The indicator, designated Model DLI-6R, is of the servo-null balance type with digital readout providing a reading of 0.1 per cent without need for interpolation. It is provided with a transistor regulated dc power supply for the load cells and an input filter that integrates force pulsations on the cells. A calibration circuit provides a quick, accurate facility to insure proper setting of each span control. **Performance Measurements Co.**, 15120 Third Ave., Detroit 3, Mich.

Circle 453 on Page 35



Digital Transducers

Series of digital transducers will measure pressure, flow, temperature, or other variables, and provide a digital output in the form of contact closures for data recording or transmission. Designated the DX-100 Series, these transducers employ mechanical force amplifiers to drive shaft position encoders from bourdon tubes, bellows, diaphragms, or similar devices. Drive power for the units is obtained from a small electric motor. Optional equipment may include a deviation or upset alarm detector. Components are available for incorporating the units into data recording or transmission systems. Explosion-proof models are available. **Datex Corp.**, 1307 S. Myrtle Ave., Monrovia, Calif.

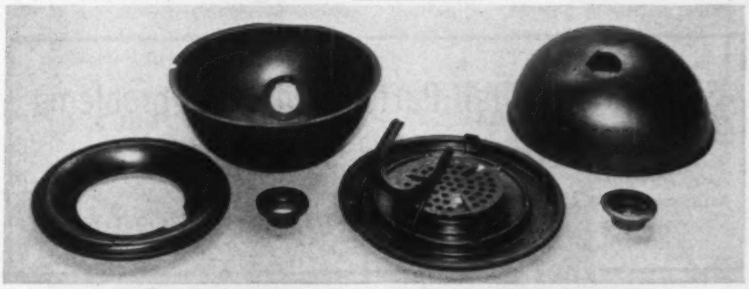
Circle 454 on Page 35

Predetermining Counters

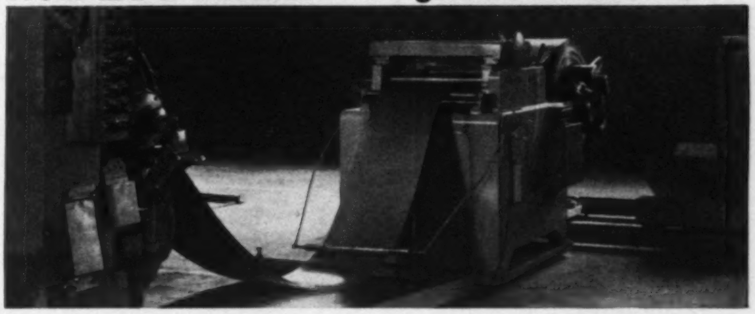
Line of transistorized predetermining counters is applicable to both laboratory and industrial areas of use. They can be used for measuring length, batching, counting irregularly shaped objects, or controlling processes. The counters will operate

The HOOVER Constellation Cleans

with parts like these stamped



From LITTELL-Straightened Stock



The marvelous efficiency with which this modern appliance cleans is matched by the effective punch press work that produces the Hoover Constellation's many stamped parts. Included are stampings of great variety in size, shape and degree of complexity. Coil stock is prepared for these exacting stamping and blanking operations on Littell Straighteners. Littell Reels, exclusively, are used in the modern Press Room of the Hoover Plant at North Canton, Ohio.

LITTELL REELS supply the stock in a smooth, even flow

LITTELL STRAIGHTENERS remove coil curvature, send flat stock into the press

F. J. LITTELL MACHINE CO.

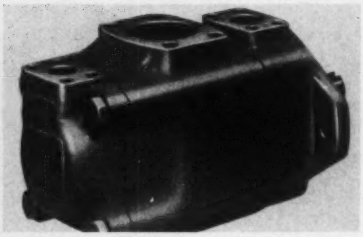
COILY SAYS..."Be informed on modern coil stock handling. Get these free Littell Catalogs"
Series "A" and "B" Catalogs for FEEDS
Series "C" Catalogs for STRAIGHTENERS
Series "D" Catalogs for REELS

4105 N. RAVENSWOOD AVENUE, CHICAGO 13, ILLINOIS

Circle 702 on Page 35

at 5000 counts per second from a 5 to 25 volt sine or square-wave pulse or from a photohead. They will count up to 1,000,000 and can operate with several sets of preset numbers for sequential predetermining. When the counters reach the adjustable preset number, an output circuit capable of switching 10 amperes is actuated, and the units automatically reset to zero—ready for the next count. **Ardwin Microlab Inc.**, 21 Spencer St., Stoneham, Mass.

Circle 455 on Page 35



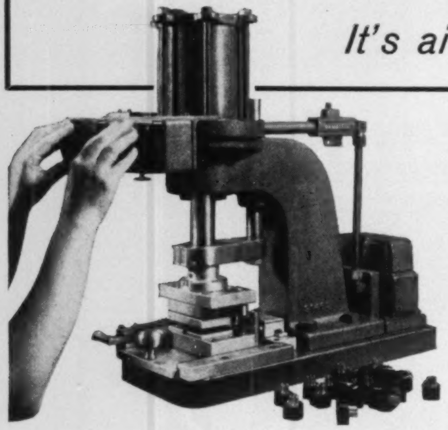
Double Pumps

Double pumping units have been added to a line of high performance vane type hydraulic pumps. Single pumps are used on agricultural, construction, earthmoving, material handling, and other mobile equipment. The new double pumps extend the range of applications by providing one power source for two separate hydraulic circuits or greater volume through combined delivery of both sections. These pumps are designed for normal operation at speeds to 2000 rpm and pressures to 2000 psi. A wide variety of ring sizes available in each section of a double pump offers a selection of capacities ranging from 8 gpm in the small section to 77 gpm in the large section. **Vickers Inc.**, Detroit 32, Mich.

Circle 456 on Page 35

Solve your "Small Parts" production problems with a **HANNIFIN "HAN-D-PRESS"**

It's air operated!



The husky Hannifin "Han-D-Press" takes operator fatigue out of light production operations where speed is the key to economy. A safe, easy-to-operate Hannifin air-operated bench press can handle these sometimes troublesome jobs better, faster and easier.

RIVETING
STAKING
PUNCHING
PRESSING
ASSEMBLING
MARKING

CHECK THESE FEATURES:

- Electric control through Hannifin 4-way solenoid-actuated valve.
- Guided ram. Speed easily adjustable. Automatic return.
- Removable steel base plate. Easy to change job set-ups using alternate work bases.
- Minimum maintenance. Rigid frame; cylinder "tru-bored" and honed.
- Half-ton and one-ton models. Low prices. Immediate delivery.

Call Your Hannifin Man for Complete Information

HANNIFIN COMPANY
541 South Wolf Road • Des Plaines, Illinois

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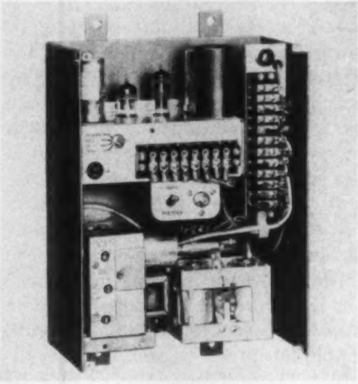
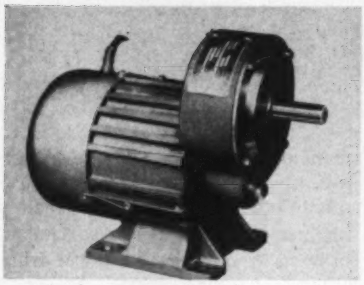
Circle 703 on Page 35



Analog Computer

Unit is designed to make three basic computations on a process variable. It can extract the square root of a single input or ratio or multiply two inputs from any primary transmitter. Its output signal is an accurate analog value for the given mathematical function and can be used to directly operate any Autronic recorder, indicator, or controller. Model C4A/z computer can be used to permit electronic instrumentation to be utilized for many control functions that formerly required pneumatic systems, to compute and control linear flow by using it to extract the square root of the signal from a differential-pressure transmitter measuring the pressure drop across an orifice plate, and in pumping stations as the basis of a system that controls compressor horsepower according to simple computations made by multiplying pressure by flow. Input and output signals of the computer are within the standard Autronic range of 0 to 0.5 volt ac. Unit operates on regular 115 volt power. **Swartwout Div., Crane Co.,** Hooksett Industrial Park, Manchester, N. H.

Circle 457 on Page 35



Induction Motor

High starting torque of this induction motor makes it ideally suited to hoist, gear pump, and compressor applications. Thermally protected and explosion proof, this continuous duty motor is totally enclosed, fan cooled, base mounted, and of rugged construction. DEF-15-1 motor qualifies according to the humidity, salt spray, sand, dust, shock, and vibration specifications of MIL-E-5272A, and it also conforms to the applicable proportions of MIL-M-7969A. Motor is rated at 1/3 hp. Voltage is 200/400 volts at 400 cps. Speed is 1490 rpm. Torque at full load is 14.2 in. lb.; starting torque is 71.25 in. lb. **Kearfott Div., General Precision Inc.,** 1150 McBride Ave., Little Falls, N. J.

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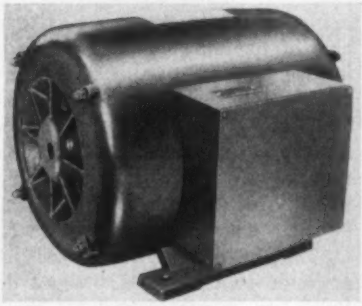
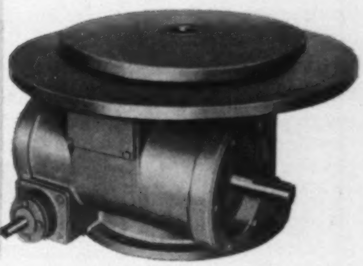


Frequency Converter

Brushless frequency converter for single phase drive is designed to supply three-phase, 400 cycle power from a 60-cycle source. Uti-

Why Index Mechanically

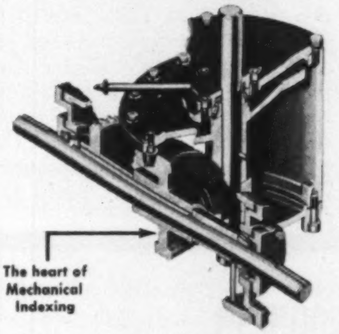


Important Features of Mechanical Transfer–

● SHOCK FREE TRANSFER OF MASSIVE LOADS

Made possible by cams designed and built to precise specifications to provide a high speed index or transfer motion with controlled acceleration and deceleration.

● ACCURACY OF INDEX



No other means provides such a high degree of precision repeatability of index. Regardless of number of positions accuracy is maintained. Transfer is never free—it is always contained by a tapered cam follower in the tapered cam path.

● SYNCHRONIZED TOOLING ACTUATION

Continued motion of the index cam shaft provides the power and basic motion for tooling actuation with positive mechanical interlock.

● INHERENT LOW MAINTENANCE

Standard Tool indexing equipment is practically maintenance-free due to its extreme precision manufacture and its carefully balanced components. Tapered roller bearings used throughout provide long durable service.

● TECHNICAL BOOKLETS

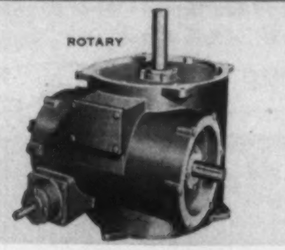
Fact-filled booklets showing indexing positions, tolerances, available dial and tooling plates, load ratings, dimensions and other information are available without cost. Standard Tool engineers will be pleased to assist you in selecting the indexing unit best suited to your particular requirements.

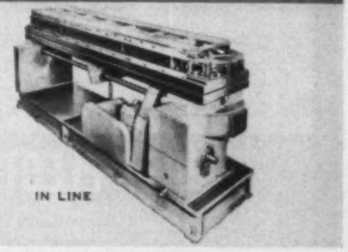
Better Products at Lower Costs thru Better Methods!

MACHINERY DIVISION

STANDARD TOOL & MANUFACTURING CO.
700 SCHUYLER AVENUE LYNDHURST, NEW JERSEY

SELECT FROM A FULL RANGE OF UNITS—IN LINE OR ROTARY

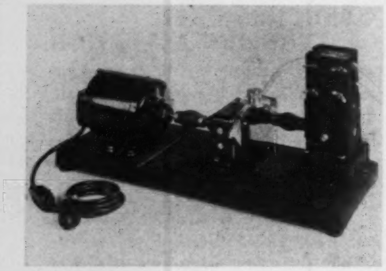




Circle 704 on Page 35

lizing a low-slip, single phase motor built into a cast aluminum shell, integral with a 400-cycle alternator, the low intrinsic regulation characteristic of this unit eliminates the need for an external regulator. Output of the unit is three-phase, four-wire, 120/208 volt, 2.5 kva. Other ratings in this model are single or three phase drive, from 125 va to 3 kva. **Georator Corp.**, Manassas, Va.

Circle 459 on Page 35



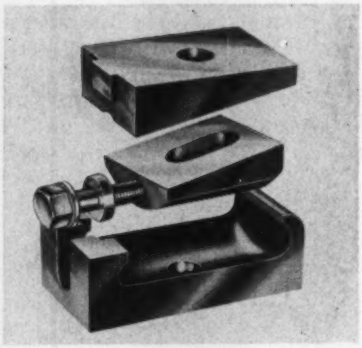
Liquid and Slurry Pump

Pump is suitable for lower capacity ranges. It utilizes the principle of moving steel fingers in a wave-like motion over flexible tubing to pump liquids, gases, and slurries. Model T-8 pump accommodates tubes of 1/4, 3/16, and 1/8 inch ID, as well as 1/16 inch ID by 1/16 inch wall, and 1/32 inch ID by 1/32 inch wall. Gum rubber, silicone rubber, surgical gum latex, Neoprene, or polyvinyl tubes are satisfactory. Capacity range of the unit is 0.1 cc per minute to 250 cc per minute. Standard unit includes a Model 14 Revco Zero-Max speed changer and a 1/12 hp open motor with switch, all mounted on an aluminum base. **Sigmamotor Inc.**, 87 N. Main St., Middleport, N. Y.

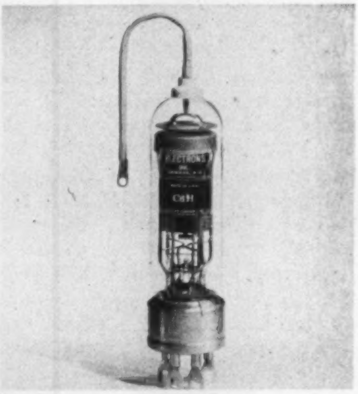
Circle 460 on Page 35

Leveling Jacks

Series of adjustable leveling jacks, with capacities to 20,000 lbs, are available for precise level installation of machine tools, automation lines, and other tool room and production equipment. Series, designated J-H leveling jacks, are designed for use at corners, centers, or along entire machine bases. They can be installed wherever equipment needs support. The jacks permit up to 1/4-inch vertical adjustment and feature two interacting inclined planes which give smooth upward or downward control without lateral movement. Self-compensating concave base counteracts unevenness of floor. **Enterprise Machine-Parts Corp.**, 2732 Jerome, Detroit 12, Mich.



Circle 461 on Page 35



Xenon Thyratrons

Line of xenon thyratrons is capable of handling up to 1700 peak inverse volts. These all-xenon, high-power thyratrons have a commutation factor of 130. The use of pure, xenon-gas filling results in low tube drop (11v avg.) with the greatest stability of control through wide ambient temperatures (−55 to +75 C). Anode current ratings are 6.4 amps dc continuous, 12.8 amps dc for 3 sec. overload, and 80 amps oscillograph peak. The line includes five tubes, designated EL C6H-1 through EL C6H-5. These tubes have five different base and anode connections. **Electrons Inc.**, 127 Sussex Ave., Newark 3, N.J.

Circle 462 on Page 35

POST ELECTRONIC PRODUCTS

Keeps tabs on hourly production *and* count . . . too!

MODEL P2 RM

The Post P2 RM is a preset electronic counter which **also indicates hourly production rate** on a two-scale rate meter. By using this dependable component in conjunction with sheet fed machines, conveyor lines, small parts manufacturing, etc., you have the benefit of "batch" counting desired quantities. At the same time you'll be able to keep tabs on your production flow. A visual totalizer indicates unit or total batch counts.

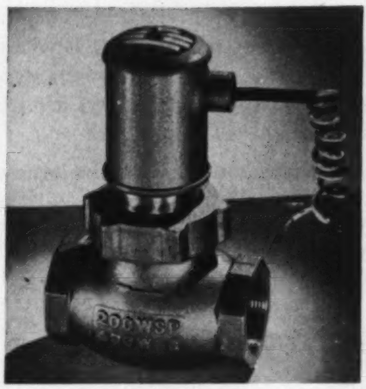
For complete details write: Decitron

POST ELECTRONIC PRODUCTS

Division of Reid Brothers Company, Inc.

12 LOTHROP ST. / BEVERLY, MASS.

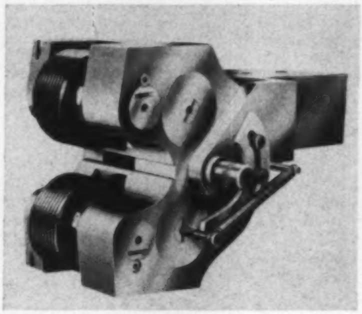
Circle 705 on Page 35



Solenoid Valve

Two-way valve has been developed for use with heavier liquids, air and gases to 400 psi (steam to 200 psi) and temperatures up to 450 F. Two models are available, Model Q (normally closed) and Model QR (normally open). Standard features include heavy duty coil assembly, unbreakable piston rings, waterproof epoxy resin coils, and guided pilot valve seat. **J. D. Gould Co.,** 4707 Massachusetts Ave., Indianapolis 18, Ind.

Circle 463 on Page 35

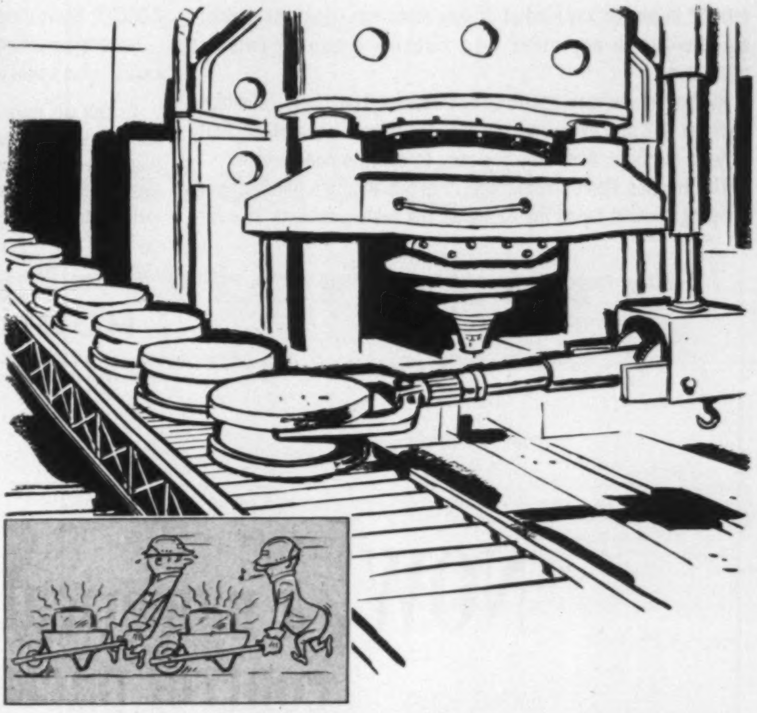


Thread Roller

Unit has been developed to roll a diametrical range from 1½ to 3¼ inches. It is applicable to turret and tracer lathes and to the larger automatic chuckers and bar automatics. When applied to lathes, it must be used on machines equipped with power cross feed. No. 28 thread rolling attachment is manufactured and assembled with precision to give maximum tool life. **Landis Machine Co.,** Waynesboro, Pa.

Circle 464 on Page 35

New twists in programmed manipulation from General Mills



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Many of industry's awkward handling problems are *still* being solved with relatively primitive manual techniques. You've heard the beefs! Moving heavy, bulky materials . . . hazardous environmental conditions . . . precise coordination—these are tough requisites for any materials-handling system.

Here's a way to free production workers of the drudgery, boredom and danger inherent in many industrial tasks . . . and save money too! General Mills electro-mechanical manipulators were developed for atomic installations requiring delicate handling in untenable radioactive areas. Our technical know-how and engineering experience suggest a number of industrial possibilities for solving your tough handling problem.

Coupled with a General Mills analog controller, the versatile Mechanical Arm can automatically play back extremely complex wrist-arm sequences . . . tirelessly, perpetually and without human error. Low cost recording medium permits automation of short run repetitive operations . . . with instruction changes made in minutes.

For more facts on programmed manipulation, write for our booklet *Automatic Handling:* General Mills, Nuclear Equipment Dept., 419 North Fifth Street, Minneapolis 1, Minnesota.

NUCLEAR EQUIPMENT DEPARTMENT

General Mills MECHANICAL ARMS
First in Remote Handling

Circle 706 on Page 35

Hughes two-axis control system, with positioning table, can be retrofit to almost any kind of drilling machine—single or multiple spindle—or to any other type machine requiring two-axis positioning.

Hughes numerical controls will reduce lead time, eliminate complex jigs and expensive tooling, and increase the productivity of your machine. And, they are easy to operate and service!

The Hughes Positioning Table is automatically operated from pre-programmed taped instructions. The table positions at a rate of 150 inches per minute; has repeatable accuracy to within 0.0002". Measuring circuit and drive motors are fully integrated.

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To find out more about how Hughes numerical controls can increase your profits, write, teletype (TWX INGL 4117) or call collect: Hughes Industrial Systems Division, P.O. Box 90904, International Airport Station, Los Angeles 45, California. For export information, please write: Hughes International, Culver City, California.

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AUTOMATION

catalogs and literature

Latest automation information. For copies use card on page 35.

Industrial Automation Systems

Industrial Electronics Div., General Electric Co., Electronics Park, Syracuse, N. Y.—16 page booklet—Booklet GED 3908 is a summary of G.E.'s capabilities in industrial automation systems. A discussion is provided of the automation situation facing management today. Details are given on complete automation systems, control systems and components, instrumentation and sensing systems, computer systems, and communication systems.

Circle 465 on Page 35

Speed Measurement Systems

Electronic Div., Meriam Instrument Co., 10920 Madison Ave., Cleveland 2, Ohio—6 page pamphlet—Bulletin 2000 entitled "Digital Speed Measurement Systems" illustrates instrumentation designed to provide accurate and trouble-free methods for measuring, indicating, or recording rotative motions. It provides details on magnetic and photoelectric pickups, electronic tachometers, and in-line readouts built for heavy-duty industrial and military applications where temperature, moisture, and vibration conditions are problems. Pickups may be installed as far away as 500 ft from the tachometers. Specification tables are co-ordinated with recommendations for the application, mounting, and coupling of each model.

Circle 466 on Page 35

Stepping Synchronous Motors

Superior Electric Co., Dept. SS, Bristol, Conn.—4 page pamphlet—Data Sheet No. 1 gives an explanation of the use of Slo-Syn synchronous motors as dc stepping motors. It explains and graphically shows stepping principles of permanent magnet type motors and contains diagrams and speed-torque characteristics charts. Bifilar motors which have twice as many winding turns as standard motors are also described.

Circle 467 on Page 35

Feed Tables and Machine Beds

Master Mfg. Co. Inc., Subsidiary, Dunmore Co., 1305 East Ave. A, Hutchinson, Kans. — 28 page catalog — Data on feed tables and machine beds are contained in Catalog 260. Details are provided on feed tables with various types of saddles and cross slides. Electric motor, hydraulic, air, and air-hydraulic power drives for different feed tables are discussed and illustrated. An erector type bed for use with a multiple spindle machine is explained and illustrated, as well as various feed table accessories.

Circle 468 on Page 35

Packaged Bearings

Tann Bearing Co., 2741 E. Congress, Detroit 7, Mich.—4 page pamphlet—Brochure illustrates and explains a Hy-Film line of packaged bearings which run on hydrodynamic oil films. Diagram illustrates operating principle of oil films. Specifications chart compares 10 bearings in line and shows dimensions. Nine graphs and charts give complete operating characteristics of bearings and show how to compute life at various speeds and temperatures. Charts also show the amount of torque consumed and the hp loss at different speeds and temperatures. The brochure describes an electron bearing analyzer used to test bearings and compute bearing characteristics.

Circle 469 on Page 35

Unloading Valve

Fluid Controls Inc., Box 186, Mentor, Ohio—3 one-page pamphlets—Data sheets detail the use and operation of an adjustable unloading valve. They contain complete engineering and design information, and feature schematic drawings, typical circuit applications, flow characteristics, and all pertinent dimensions. The valve automatically diverts full pump flow to the reservoir after a predetermined system pressure has been reached. It features a 5 to 20 per cent adjustable differential between load and unload pressure and complete loading and unloading. Instructions for adjusting the valve are provided.

Circle 470 on Page 35

Fillers and Sealers

Sales Dept., J. L. Ferguson Co., P. O. Box 1226, Joliet, Ill.—6 page pamphlet—Bulletin 100-44 describes a variety of machines which form, fill, and glue-seal folding cartons as part of an in-line production setup. Available for both single serving and sample type packages and standard carton units, in a wide range of types and sizes, these machines are both illustrated and explained. Schematic drawings indicate their various dimensions.

Circle 471 on Page 35

Fluid Meters

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio—8 page bulletin—Bulletin 20 contains data on a line of fluid meters. Information is given on operation, ranges, and installation requirements of these devices. Information is also provided on integrators, compensators, and primary elements. Schematic diagrams and photographs illustrate construction features of the units.

Circle 472 on Page 35

Pulse Switch

Micro Switch, Div., Minneapolis-Honeywell Regulator Co., Freeport, Ill.—2 page pamphlet—Industrial pulse switch is subject of Data Sheet 173. Unit is designed for applications in which momentary opening and/or closing of a circuit is necessary. Adjustable pulse length feature of the switch is discussed as well as its electrical ratings of 10 amps—125, 250, or 480 v ac; ½ amp—125 v dc; ¼ amp—250 v dc.

Circle 473 on Page 35

Instrumentation Tubing

Superior Tube Co., 1727 Germantown Ave., Norristown, Pa.—12 page booklet—Basic facts about various types of small diameter tubing for instrument applications are available in Bulletin 380. Tubing described and illustrated includes thermometer bulb, capillary, Bourdon, torque, bellows, thermocouple, thermocouple protection, fire detection, linkage, recording pen, and gas chromatography. This line of tubing is supplied in outside diameters from 0.010 through 1⅛ inch. It may be composed of such materials as stainless steel, carbon and alloy steels, and beryllium copper. Two forms of tubing, seamless and welded, are discussed.

Circle 474 on Page 35

Variable Speed Drives

Louis Allis Co., Dept. P, 427 E. Stewart St., Milwaukee 1, Wis.—4 page pamphlet—Bulletin 101 describes the operation and performance of a line of electronic variable speed drives, designated Select-A-Spede. These drives range in size from ¾ to 4 hp, and feature a dc motor powered from a compact, wall mounted electronic control panel which is controlled by an operator's remote station. They

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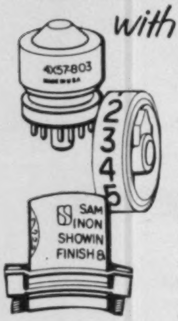

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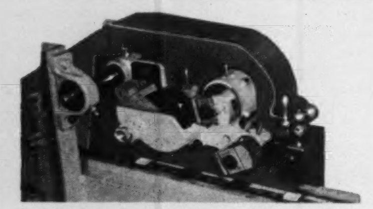

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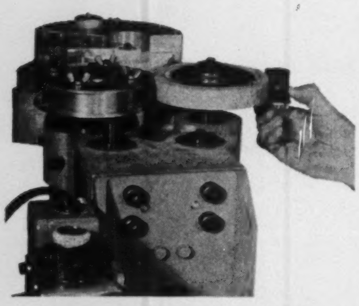

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Circle 708 on Page 35

provide accurate speed regulation to within 3 per cent from no-load to full-load over an adjustable 8:1 speed range. Applications include machine tools, conveyors, pumps, test equipment, textiles, paper converting and printing machinery, extended speed ranges, tachometers for remote speed indicators, and double or triple gear reducers.

Circle 475 on Page 35

Circular Chain

Acme Chain Corp., Holyoke, Mass.—4 page pamphlet—Bulletin 8 contains information on a roller chain designed to operate on curves. Its most common use is to act as a transfer medium from one straight line conveyor to another. Construction details as well as various views of typical installations in a bakery are illustrated.

Circle 476 on Page 35

Digital Data Handling

Digitronics Corp., Albertson Ave., Albertson, L. I., N. Y.—14 page booklet—Brochure contains information regarding electronic digital data handling for communication systems. Equipment as well as techniques and devices presently in test for accurate and speedy flow of information between the computer and remote stations are covered. A description of two types of hardware designed to enable communications to bridge the data processing gap is provided. The equipment converts information between punched paper and magnetic tape in either direction and provides for transmission as well as conversion of data. Speeds and equipment for all types of transmission media are compared, including teletype grade facilities, telephone grade facilities, audio, and video.

Circle 477 on Page 35

Bar and Chucking Automatic

Cleveland Automatic Machine Co., Cincinnati 12, Ohio—8 page bulletin—Unit, designated Model AB single spindle bar and chucking automatic, is subject of Catalog 460. Precision feed monitor of the machine that indicates exactly, in inches per minute, the feed rate for each forward and reverse setting of the five turret tools is discussed. Other machine features described and illustrated include 112 spindle speeds which can range from 24 to 1820 rpm, convertability from bar to chucking automatic in 30 minutes, and dial controlled tool feeds.

Circle 478 on Page 35

Magnetic Reed Switches

Hamlin Inc., Lake and Grove Sts., Lake Mills, Wis.—6 page pamphlet—Bulletin contains data on a line of magnetic reed switches. These switches are designed to handle larger loads with more constant contact resistance throughout their lives. Applications include uses for such devices as electromagnetic relays, position indicators, counting instruments, liquid level switches, and flow meters. Test charts for life expectancy, the method of code identification, and a permanent magnet chart with typical make and break contact distances are shown for proper selection and proper application of the switches.

Circle 479 on Page 35

Check-Weighing Systems

Weighing & Controls Inc., Hatboro 773, Pa.—4 page pamphlet—Bulletin 50 covers a line of check-weighing systems that can be applied to all types of dry or liquid, single or multi-unit containers to provide a continuous check on the filling accuracy of packaging equipment. These systems can be assembled from a variety of platform scales, readout equipment, and control instrumentation. Weighing can be either continuous or intermittent. Details are provided on a Uniforce Platform Scale that has an accuracy of ±0.25 per cent of calibrated weight range.

Circle 480 on Page 35

Furnaces and Ovens

L & L Mfg. Co., 136 Eighth St., Upland, Pa.—16 page booklet—Catalog provides details on a line of industrial furnaces and ovens. A wide range of sizes is listed, from front loading bench and floor models to top loading units. Dyna-Trol furnaces feature a temperature range from 300 to 2300 F. With forced convection fans, temperatures of 150 to 1875 F can be maintained. Details are also provided on indicating millivoltmeter controllers for use with the furnaces.

Circle 481 on Page 35

Conveyors

Conveyor Specialty Co. Inc., North Quincy, Mass.—3 pamphlets—Bulletin EB460 provides data on Series E interchangeable components for both inclined and horizontal conveyors. Data sheet EP2560 describes Series EP end drive live roll conveyors suitable for handling light packages and other types of small unit loads. Bulletin GC-859 contains data regarding both gravity wheel and gravity roller conveyors. It includes straight and curve as well as frog, gate, and switch sections. All of the material provided is suitably illustrated by means of photographs and schematic diagrams.

Circle 482 on Page 35

Electric Motor Controls

Furnas Electric Co., 1128 McKee St., Batavia, Ill.—56 page catalog—Catalog 60 provides descriptions and ratings for magnetic starters; drum controllers; pressure, foot, and limit switches; and pushbuttons and related pilot devices. Motor rating, heater coil data, and other simplified tables are provided to simplify control selection.

Circle 483 on Page 35

Gas Density Balance

Scientific and Process Instruments Div., Beckman Instruments Inc., Technical Information Dept., 2500 Fullerton Rd., Fullerton, Calif.—4 page pamphlet—Data are contained in Bulletin GA-4004 on a continuous gas density balance. This instrument is used in applications where processes stream density is critical, such as for compositional analysis of two component streams of substantially different densities, and for continuous hydrogen readings on hydrogen blanketed turbine generators. Model 3A consists of a measuring cell, amplifier, power supply, and temperature controls. Features noted are rapid response to changes in density, corrosion resistance, positive accuracy check, and single or multiple-range linear read-

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Circle 709 on Page 35

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Circle 710 on Page 35

out. A precisely regulated power supply that insures operation accuracy, independent of line voltage variations up to ±15 per cent, is described.

Circle 484 on Page 35

Bus Duct

Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.—12 page booklet—Booklet 30-663 contains application data for high-frequency bus duct. The descriptions, drawings, dimensions, specifications, and engineering and test data give specific information needed to lay out, specify, and install this type of duct. Applications of the unit include induction heating systems, and air-frame and electronics manufacturing facilities.

Circle 485 on Page 35

Cylinders

Miller Fluid Power Div., Flick-Reedy Corp., 7N015 York Rd., Bensenville, Ill.—4 page pamphlet—This brochure contains information regarding a line of pneumatic and hydraulic power cylinders. The pneumatic cylinders are available in 1½ through 14-inch bores. Model J hydraulic cylinders are rated for 500-2500 psi service and are available in 1½ to 14-inch bores. Model H hydraulic cylinders are designed for 3000-5000 psi service and are available in 1½ through 8-inch bores. Data are also provided on stock clevises, clevis and eye brackets, eyes, and pins. Rotated ports, rotated cushion adjustments, and mixed mountings are covered.

Circle 486 on Page 35

Silicone Rubber Windings

U. S. Electrical Motors Inc., P. O. Box 2058 Terminal Annex, Los Angeles 54, Calif.—2 page bulletin—Bulletin F-2022 contains data on silicone rubber protection used on windings of U. S. Electrical form-wound motors of 150 hp and up. These windings utilize the inherent insulating qualities of silicone rubber—applied in successive layers over pre-dipped coils so that a uniform thickness is achieved. The entire sheath is then welded into a homogeneous dielectric material that is impervious to chemicals, moisture, heat, weathering, vibration, oxidizing, fungus, salt air, spray, and detergents.

Circle 487 on Page 35

Electronic Counters

Electronic Controls Div., Veeder-Root Inc., Danvers, Mass.—collection of data sheets—These data sheets contain information on a line of electronic counters. Details are given on electronic predetermining counters, electric predetermining counters, and complete counting packages, designated Count-Paks. Schematic diagrams illustrate photo-head assemblies used with the counters.

Circle 488 on Page 35

Digital Measuring Instruments

Non-Linear Systems Inc., Del Mar, Calif.—12 page booklet—Bulletin 481-1 describes a series of digital measuring instruments including a digital voltmeter and digital ohmmeter. Both instruments are used in a wide range of visual measuring applications such as production testing, instrument calibration, quality con-

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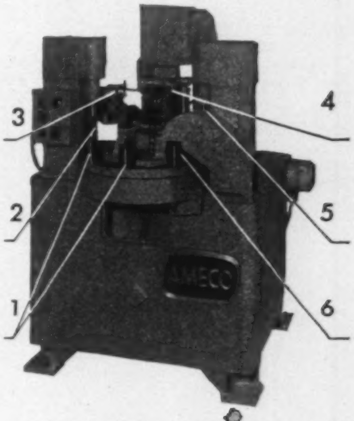

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Circle 711 on Page 35

trol, laboratory testing, and receiving inspection. They are capable of measuring either dc voltage or resistance.

Circle 489 on Page 35

High Temperature Ovens

Trent Inc., 211 Leverington Ave., Philadelphia 27, Pa.—12 page booklet—Bulletin 71-TH provides information on a line of industrial high temperature, recirculating, gravity and forced convection ovens. Standard basic ovens as well as specially designed ovens are covered. Folded-and-formed ribbon type resistance heating elements, which allow accurate process control over a wide temperature range, are discussed.

Circle 490 on Page 35

Magnetic Lever Valve

Industrial Controls Div., General Controls Co., 801 Allen Ave., Glendale 1, Calif.—6 page pamphlet—Subject of this bulletin is a K-10 two-way magnetic lever valve. Details are given and applications are discussed for both normally open and closed models of the valve. A K-10K magnetic valve, designed to handle mildly corrosive fluids, is also described.

Circle 491 on Page 35

Measuring and Control Units

United States Gauge, Div., American Machine and Metals Inc., Sellersville, Pa.—6 page pamphlet—Pressure gages, thermometers, and control instruments are described in Bulletin 3020. Pressure gages are the bourdon-tube type covering a wide variety of industrial applications. Dial and glass-tube thermometers, panel-type and multi-angle thermometers are described and illustrated. Control instruments include indicating controllers, valve positioner and pilot options, recorders, chemical attachments and accessories. Descriptive photographs accompany each item discussed.

Circle 492 on Page 35

Industrial Instruments

Statham Instruments Inc., Dept. S, 12401 W. Olympic Blvd., Los Angeles 64, Calif.—32 page catalog—Manual presents general information on such devices as pressure transducers, linear and angular accelerometers, load cells, amplifiers, power supplies, bridge balances, strain gages, and force/displacement transducers. Selection charts keyed to instrument ranges are included as well as tables of conversion factors for pressure, force, linear acceleration, temperature, angular velocity, plane angles, and weight.

Circle 493 on Page 35

Roller Bearing Pillow Blocks

Bantam Bearings Div., Torrington Co., South Bend 21, Ind.—20 page booklet—Catalog 860 covers a complete line of spherical roller bearing pillow blocks. These pillow blocks are available in 143 sizes and are ideally suited for a wide variety of applications. Two heavy duty series are offered—Series SAF with two bolts clamping cap to base, and Series SDAF with heavier castings and four cap bolts. Housing seats are machined to bearing widths plus 3/8 inch. This permits each pillow block to be used as a floating unit, or, with standard 3/8-inch wide stablizing ring in place, as a fixed pillow block.

Circle 494 on Page 35

Bulk Handling Controls

Electronic Controls Div., Flo-Tronics Inc., 1420 Zarthan Ave., Minneapolis 16, Minn.—5 page pamphlet—ECD1-6008 Controls Brochure describes a line of controls for bulk handling of dry materials. These controls are applicable to process automation, material movement, and quantity measurement. A listing is provided of typical control instruments and equipment applicable to bulk-handling systems.

Circle 495 on Page 35

Time Delay Relays

Tempo Instrument Inc., P. O. Box 338, Hicksville, L. I., N. Y.—2 one-page pamphlets—Bulletin 5903-1 covers a line of electronic time delay relays, offering time delay periods from 0.020 to 300 seconds, with delay-on-drop-out. Bulletin 5903-2 describes a line of ac operated electronic time delay relays. These units are available with time delay periods from 0.050 to 300 seconds, with delay action occurring on pull-in. They have a miniature built-in power supply for converting ac input to dc.

Circle 496 on Page 35

Sensing and Switching System

Delavan Mfg. Co., West Des Moines, Iowa—2 page pamphlet—Catalog 4-1 describes a noncontact system for sensing and switching that uses ultrasonic energy for its beam. This system will sense liquids or solids, ferrous or nonferrous metals, opaque or transparent material. It will detect fast or slow moving objects at a wide range of distances. Power consumption is approximately one watt. Sensors will operate in temperatures of +220 to −100 F in a wide range of environmental conditions.

Circle 497 on Page 35

Protective Covers

Central Safety Equipment Co., Engineering Dept., 6600 Marsden St., Philadelphia 35, Pa.—4 page pamphlet—Brochure provides data on basic applications for a line of metal-formed, spirally wound cones designated Elasticones. These cones are used to protect precision parts such as lead screws, shafts, pins, and bushings from dirt, scale, and abrasion. Standard stock sizes as well as engineering dimensions are provided.

Circle 498 on Page 35

Conference Report

Computer Control Co. Inc., 983 Concord St., Framingham, Mass.—72 page handbook—This booklet records the Proceedings of the First Users' Conference on Dynamic Digital Logic. Titles of the papers presented are as follows: Application of Digital Techniques in a Meteor Burst Communication System, IBM 709 T-PAC Wiring Program, Logical Simulation Techniques Using the IBM 709, A BIDEC Converter Utilizing Dynamic Logic, A Compact Notation for 3C wiring, Mechanization of a Serial Unity Ad-

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Circle 712 on Page 35

der-Subtracter, A Method for Rounding Off a Quotient to the Nearest Integer, A Parallel Binary-Coded-Decimal Counter, A Serial Version of the BIDEC Binary to Binary-Coded-Decimal Counter, On the Generation of Periodic Pulse Patterns, The Use of Serial Techniques in the Design of an Incremental Computer, and Serial Techniques in Digital Systems. These papers report new and interesting applications of transistorized dynamic digital circuitry, their versatility, and future possibilities.

Circle 499 on Page 35

Fusion Welding Equipment

Sciaky Bros. Inc., Dept. F-W-1, 4915 W. 67th St., Chicago 38, Ill.—28 page catalog—Catalog is essentially a pictorial report of a line of highly precise, fully automatic fusion welding equipment. Featured are actual applications where subject equipment has been in use for the past two years for North American Aviation's B-70 Program, Raytheon's *Hawk* processing, and other projects.

Circle 500 on Page 35

Oscillating Motors

Roto-Tork Mfg. Co., 23919 Little Mack, St. Clair Shores, Mich.—8 page bulletin—Booklet 601 describes a line of pneumatic or hydraulic oscillating motors with instant full torque. These motors are used on such equipment as materials handling, foundry, machine tool, paper making, steel mill, power press, and welding. They can produce torques from 100 inch-pounds to 430,000 inch-pounds on standard units. The heavy duty line is built for 2000 psi operation. Details and illustrations are provided on both double vane models with 100-degree rotation and single vane with 280-degree rotation.

Circle 501 on Page 35

Graphite Woven Fabrics

National Carbon Co., 270 Park Ave., New York 17, N. Y.—4 page pamphlet—Data on graphite woven fabrics are presented in Bulletin 101 HJ. These fabrics are available in three standard grades with tensile strengths of 50,000 to 100,000 psi. Textile characteristics such as filament diameter and weave are tabulated, and properties of the various grades are listed. Combinations of the properties that make graphite cloth particularly suited to specific applications are discussed.

Circle 502 on Page 35

Numerical Control Tape

National Vulcanized Fibre Co., 1060 Beech St., Wilmington 99, Del.—2 page pamphlet—Bulletin 1313 describes Peerless brand control tape for machine tool control and data processing applications. Made of vulcanized fiber, this control tape has toughness, durability, a low stretch factor, and high opacity. It is ideally suited for continuous cycling use and for production of master tapes.

Circle 503 on Page 35

Bearings and Rod Ends

Sealmaster Bearing Div., Stephens-Adamson Mfg. Co., Ridgeway Ave., Aurora, Ill. —16 page booklet—Catalog 560 describes a line of spherical bearings and rod ends. These units are available in a wide range of designs, bore diameters, thread sizes, and materials to meet most application requirements. Illustrative photographs as well as series specification charts are included.

Circle 504 on Page 35

Compact Machine Tools

Jones & Lamson Machine Co., 160 Clinton St., Springfield, Vt.—3 booklets—Data are contained in these booklets on a line of small precision machine tools. Details are provided on a boring machine, Model 6, applicable for high production of close tolerance turning, boring, and facing work. Model 6B gun drilling machine featuring spindle speeds up to 15,000 rpm is also described as well as a small thread grinder specifically designed for small lot production.

Circle 505 on Page 35

Precision Mechanical Springs

Associated Spring Corp., Bristol, Conn. —16 page booklet—Booklet serves as a guide to lower assembled costs for products containing springs. Handling, quality, and purchasing details are provided. Various types of springs such as hairsprings and torsion, extension, and compression springs are illustrated, as are various methods of spring packaging.

Circle 506 on Page 35

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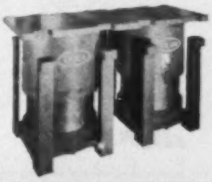

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Circle 713 on Page 35

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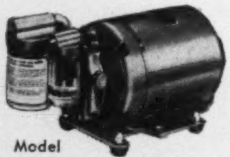
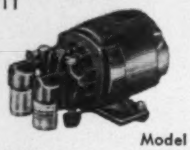


Model 0211



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Circle 715 on Page 35

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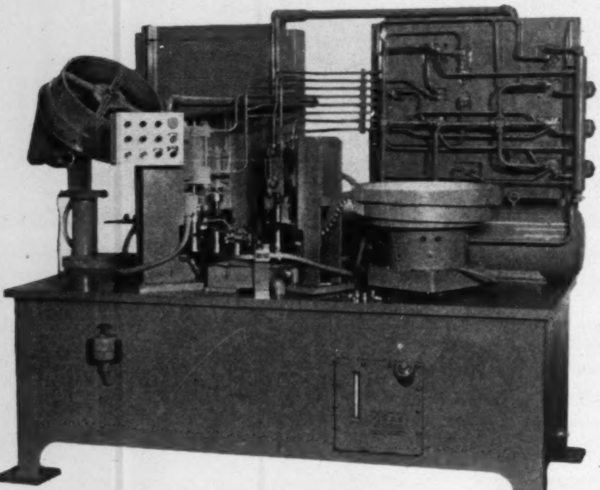

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AUTOMATION abstracts

COMPUTER AIDS PIPELINE CONTROL

By E. E. RICHARDSON and A. C. WINTER
Control Data Corp. Control Corp.
Minneapolis, Minn.

COMPLEXITY of calculations involved in the analysis of pipeline flow suggests that a pipeline with variable load factor is a very good candidate for full closed-loop automation. Indeed, the amount of calculation required to correct for one load change would tax a system dispatcher with a hand calculator for a period of several hours. There is considerable doubt that a system with a severely varying load could be dispatched without the aid of an on-line computer for system computations and analysis. This paper summarizes the findings of a feasibility study leading to a closed-loop, computer-controlled, automation system to control such a pipeline with good economy and stability of operation.

The pipeline postulated for this study is approximately 600 miles in length and is equipped with seven compressor stations (approximately 70 miles from one another). Four sources of natural gas feed the system, and gas is removed at seven different load points. Compressor equipment is of several various types, but characteristic operation curves are assumed for each type used. Expected demand curves are available for each customer serviced.

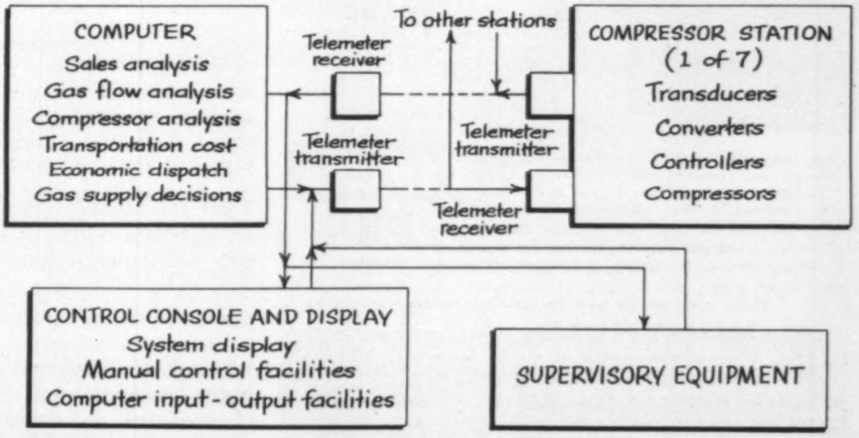
General Approach

The general control system required for closed-loop control of the pipeline is shown in *Fig.* 1. All compressor stations and metering points are connected to the computer by a two-way telemetry channel. Gas flow, temperature, and pressures are measured at all input and output points, so that system input-output balance may be maintained. Compressor parameters, such as suction temperatures and pressure, are measured so that the necessary compressor calculations can be made. Compressor operation and safety parameters are also measured and made available to the computer program for safety surveillance.

For each value of system throughput, an analysis must be made to derive the proper compressor set-points. This analysis may be briefly described as follows: 1. By use of Panhandle Gas Flow Formula, determine pressure drop in each pipeline segment. 2. By use of compressor characteristic curves, determine set-point to achieve desired compressor operation for system stability and economy. 3. By use of compression equations, determine conditions of output temperature and pressure so that pressure gradient in next line segment can be calculated. 4. Continue for all pipeline segments until set-points for all compressors have been determined.

Since the system load curve is one of continuous change, system calculations must be made frequently. The computations required for each system analysis are also quite lengthy. The precise frequency of system correction required will be functionally dependent upon the change rate of the demand curve and upon the degree of tolerance allowed on customer discharge pressure.

The selection of a compressor set-point for "stability and economy" involves many conflicting requirements which must be satisfied. Each compressor type has its characteristic operation versus load reactions. Many compressors are not well suited to changing system


COMPUTER
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Gas flow analysis
Compressor analysis
Transportation cost
Economic dispatch
Gas supply decisions
To other stations
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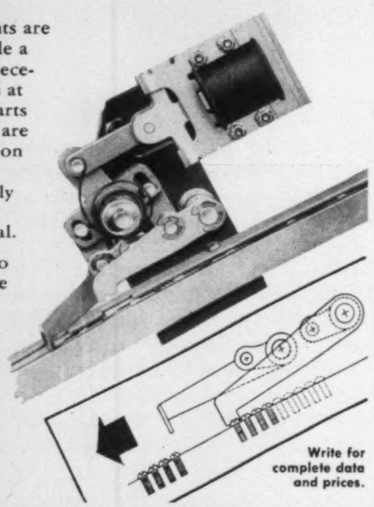

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Circle 717 on Page 35

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loads. Occasions arise where one compressor must be turned off (or bypassed) in order to properly load an adjacent compressor. Economic comparisons must be made as to whether two or more compressors should be lightly loaded as opposed to one heavily loaded and one bypassed.

After proper compressor set-points have been calculated, they must be sent from the computer to the appropriate compressor by way of the telemetry system. Controllers at the compressor site will regulate the controlled function (speed, pressure, unloader pocket, etc.) in accordance with the set-point value until a new set-point is issued.

Measurement

In the solution of the basic flow equation, pressure is the unknown variable. Supply, load point flow, and pressure are metered; at the compressor stations ground temperature, ambient temperature, discharge temperature, and suction temperature are measured. Mean flowing temperature can be calculated using an empirical formula and a sufficiently accurate determination of suction temperature can be made by calculation based on a measured discharge temperature (or vice versa).

Several flow meters (both positive displacement and orifice type) are available which provide for correction due to supercompressibility. A maximum error of 0.5 to 1 per cent is claimed on several different flow meters. Pressure transducers are available with only 0.25 per cent error. It is felt that one per cent error in measurement of gas flow is not excessive for a valid solution to the flow problem and to maintain a stable system.

Output of the transducer used will very likely be a current. This value is compared against a reference current and any deviation due to a changing variable is detected to automatically initiate a cycle for data transmission to the dispatch station. An adjustment is provided, for each quantity metered, to preset the percentage change necessary to start a new transmission. It may prove advantageous to receive all new telemeter readings at some preset time also.

Transducer outputs feed into a common analog-to-digital converter whose output is acceptable to the digital telemeter transmitter. Lockouts are provided to read only one value at a time and each variable has its own code so that the dispatch station can recognize which variable is being reported. Since seven digital telemeter channels are in use (one from each station) the central station can accept seven new readings simultaneously. These readings must be stored if display is desired for an operator. In any case, provision for storage appears to be desirable since this data is then available continuously for computer input and logging. Should no storage be used, then an elaborate system of lockouts is required to allow only one station to report in at any particular instant.

Computer Characteristics

Computer requirements call for sufficient word length to preserve data integrity through several levels of calculation and cumulative roundoff error. System

Circle 718 on Page 35

analysis requires calculation of several logarithms, exponentials, and square roots, as well as many references to compressor characteristic curve data for each system change. The frequency of system solution required and the severity of the calculations predicates a high speed computer. Memory space must be available for storage of compressor characteristic curves, customer demand data, power cost data, and many programs and subroutines. Flexible input/output characteristics are also required to allow reading of many input parameters and for the issuance of system set-points.

Supervisory and Digital Control

A differentiation should be made between "remote-manual" and "automatic" control by supervisory. In "remote-manual" control a large number of points are monitored, high speed telemetering is used, indications of progress of the compressor start sequence is received during start up, and governor control is possible. Here supervisory is an extension of the local control.

Opposed to this is the type of control where little or no reliance is placed on continuity of the communications link and supervisory is considered primarily a "set-point" operator. This type of operation requires less expensive supervisory equipment and is, generally speaking, not as fast. A less expensive communication circuit would normally be used.

It appears that in a large closed loop system the "set-point" transmission would basically be used. This allows digital transmission of set point information with memory, comparison, and controller action at the compressor station.

The controlled variable as a rule will be pressure. The computer solution specifies pressure for each compressor and this value is logged, displayed, and automatically transmitted in digital form to the compressor station. The receiver operates into a storage unit which converts the signal to an analog form. Output of the discharge pressure transducer is converted to a form compatible for comparison with the newly transmitted set point. Any difference between the two will result in an error signal which is amplified and used as the control signal to operate a fuel controller, governor setting, or whatever control exists on that particular compressor.

Loss of telemetry channel would leave any compressor station which depended on this channel operating on the last set-point issued. All normal safety interlocks concerning the compressor would still be operative. The computer would still retain in its memory information denoting the set-point of the compressor in question. The remainder of the system could therefore be varied to accommodate the compressor whose set-point could not be altered.

Many programming precautions are necessary to make the system fail-to-safety. Executive programs and subroutines would be checked for proper storage before and after usage. Reasonableness checks would be made on all system calculations prior to issuing set-points derived from these calculations. Periodic inventories would be made of the gas stored in the pipeline system to be sure that the system was not

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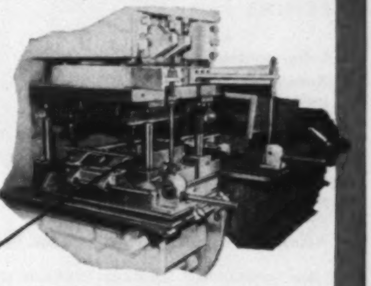

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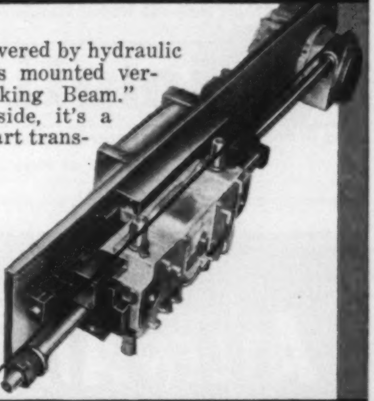

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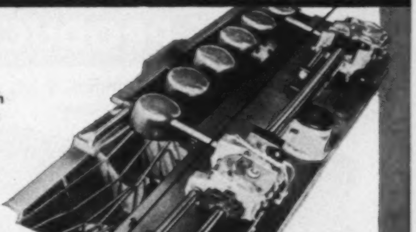

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Circle 721 on Page 35

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From a paper entitled "Computers, Dollars, and Pipelines" presented at the 1960 Annual Conference of the American Gas Association, New Orleans, May 1960.

ATTRIBUTES AND IMPLICATIONS OF MICROELECTRONICS

By ARTHUR P. STERN
Electronics Laboratory
General Electric Co.
Syracuse, N. Y.

SMALL size and reduced weight are not the most important attributes of microelectronics (microsystems, microcircuits, multifunctional components, thin circuits, solid circuits, etc.). While *small size* and attendant *reduced weight* are desirable in many and necessary in some applications, and might be at least quite glamorous in others, small size and reduced weight would not justify the huge effort invested in and the great interest evoked by microelectronics.

If the size of conventional electronic circuits were simply reduced without simultaneously reducing its power consumption, one would face a grave heat dissipating problem. Using solid state, high temperature operation is impractical and, therefore, a mandatory attribute of solid state microelectronics is *reduced power consumption.*

To arrive at the next and possibly most important attribute of solid state microelectronics, one must consider the major technical problem faced by manufacturers of electronic equipment today: *Reliability.* A great deal of work has been done in attempting to improve the reliability of components and of interconnections. However, there is a limit to what can be achieved by making components and interconnections more reliable.

Fortunately, besides improved component reliability, there exists an additional powerful means to improve system reliability and this is redundancy—redundancy on the subsystem, on the circuit, and on the component level. But redundancy means duplication, triplication, or multiplication by very high numbers of the minimum number of elements needed to perform individual system functions.

It can be seen that size, weight, and power consumption, while per se entirely secondary in many applications, gain importance through the reliability angle. One of the principal advantages of solid state microelectronics, which should make it attractive for practically all complex electronic systems, is that it might render possible high-level redundancy and, therefore, unheard of system reliability, without resulting in impractical size, weight, and power consumption of the entire system. All solid state microelectronics approaches aim at methods permitting the fabrication of entire subsystems in an integrated processing sequence. Since such methods tend to eliminate many of the interconnections between circuit components, presently made in the assembly process, an additional reason for increased reliability may exist.

The integrated fabrication process not only implies improved reliability but also the potential of *reduced cost.* The money currently spent on time and effort in the selection, ordering, testing, storing, distributing, and assembling of low-level components represents quite a savings potential. Also, increased reliability, through clever use of redundancy on the component and circuit level, may reduce the number of standby systems to be built, and thereby may contribute to reduced over-all system acquisition and maintenance cost.

Another potential advantage of solid state microelectronics, due to the production processes used in manufacturing such items is the *reduction of the design to production time cycle.* A rather lengthy cycle exists using present methods, largely because of time needed to select, order, wait for the delivery of, store, distribute for assembly, and assemble present low-level elementary components.

We are facing a situation where major portions of, or entire, circuits and subequipments may be made in an integrated processing sequence. This is a fairly long-range proposition but first starts will be made, in equipment form, within the next few years and it behooves us to consider an important business implication of this development: The disturbance of the traditional equilibrium between component manfacturer and equipment manufacturer in the electronics industry.

To describe the situation in simple terms, it is convenient to consider proposed approaches in microelectronics as filling spots in a spectrum extending from "conservative microminiaturization" to "molecular electronics."

Conservative microminiaturization involves size reduction and shape standardization of conventional components.

Molecular electronics involves making entire circuits and equipment functions in "monolithic blocks" by controlling spatial distribution of inhomogeneities in materials, mostly without identifiable components.

An intermediate approach involves making entire functions in an integrated sequence of processes, with or, at least, major portions of circuits and equipment components being identifiable but mostly nondiscrete.

In traditional electronics, and "conservative microminiaturization," the equipment manufacturer buys and assembles components manufactured by the component manufacturer. It can be assumed that except for a short time, "conservative microminiaturization" will be bypassed and practical approaches will be versions of the "intermediate approach," ultimately tending toward "molecular electronics." Then it will be difficult to distinguish between components on the one hand and circuits and equipment functions on the other.

The component manufacturer faces the danger of losing much of his business if the equipment manufacturer makes his own integrated structures. He also has the opportunity to expand his scope by trying to

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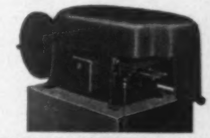

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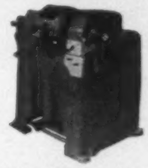

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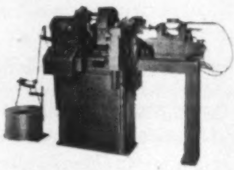

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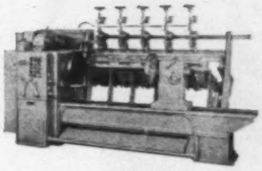

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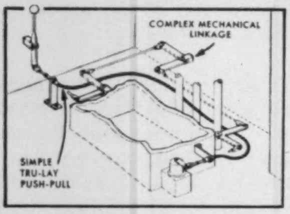

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Circle 723 on Page 35

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make and sell integrated structures to equipment manufacturers. In so doing, he has such problems as acquiring additional technology and facilities and deciding whether to make standard or custom-made integrated structures. With standard structures, he may reduce cost to a level competitive with conventional electronics but he faces the circuit designer's and equipment manufacturer's reluctance to use standard circuits. Also he needs a complete line involving great variety. If he decides to make custom structures, he has a cost problem.

Because microelectronics promises elimination of much of the present component assembly work, certain equipment manufacturers face the danger of losing a significant fraction of their "contributed value." On the other hand, if the equipment manufacturer makes integrated structures on his own, he may expand his contributed value. In so doing he faces such problems as the acquisition of entirely new technology and facilities, and making radical changes in his manufacturing process (he will be running a processing factory). Since the equipment manufacturer would "make" only for himself on a custom basis, he will have cost problems.

The business conflict between component and equipment manufacturers is related to the controversy between the technical approaches mentioned. The equipment manufacturer hopes for another printed circuit case, i.e. that microelectronics will call for relatively simple technology which he can learn to master. He pushes technical approaches close to "conventional microminiaturization." On the other hand, the component manufacturer is less afraid of complex technology, tries to get away from another printed circuit case and pushes technical approaches closer to "molecular electronics."

It is clear that the outcome of the conflict may depend to a large extent on the technical feasibility of approaches approximating "molecular electronics."

From a paper entitled "Some General Considerations on Microelectronics—An Introduction to the Microelectronic Sessions of NEC," presented at National Electronics Conference, Chicago, Oct. 1960.

INSPECTION BY ELECTRONICS

By D. R. HOUCK
Application Engineer
Radio Corp. of America
Detroit, Mich.

FIRST step in acquiring a working knowledge of electronic inspection methods is to understand the nomenclature and functions of the basic elements employed. While there are several widely used electronic systems for obtaining dimensional measurements, the functions of the elements used are, for all practical purposes, the same.

The Sensing Element. This element is often referred to as a displacement transducer. The most commonly used types are the differential transformer and the variable capacitor. The sensing element can be considered a gaging stylus which is displaced by the dimensional change of part size or by the amount of motion of the surface it is contacting.

Gage Circuit. The function of this element is to transform the electrical change caused by the displacement of the sensing element into a usable signal for deflecting the pointer of a meter or for operating electronic limit switches. The chief advantage of a system which has a variable capacitor as its sensing element is that its gage circuit has an extremely high output voltage which can be used directly without intermediate mulitstage amplifiers.

Other elements must be used to enable us to make automatic decisions from the electrical information supplied by the sensing element and gage circuit. The most often used element is the electronic switch. This element can be considered a limit switch which, rather than reacting to mechanical motion, is energized by an electrical signal of a specific magnitude from the gage circuit. The variable capacitor system employs thyratron tubes as the switches, and they are set to fire at a preset voltage value and energize a relay which can be used to operate a light, bell, or an electrically actuated sorting mechanism.

Other extremely important elements in the decision-making phase of an electronic inspection system are the computers:

Sum Computer. This element is used for adding the output signals of two gage circuits.

Difference Computer. This unit is used for subtracting the output signals of two gage circuits.

The above elements can be combined in a variety of ways to allow us to determine almost any measurable dimension and even some physical properties.

While many inspection problems can, in many cases, be solved with the use of pneumatic or electrical gaging techniques, electronic methods offer the following major advantages:

1. *High speed.* Since the time required for an electronic gaging system to resolve an answer is, for all practical purposes, negligible, the inspection rate of an electronic inspection and sorting system is limited only by the time required for the mechanical motions involved in getting the parts to and from the gaging fixture.

2. *Sensitivity and accuracy.* Under ideal laboratory conditions electronic gage circuits can be used to indicate dimensional variations in size as small as 0.000002 inch. When properly applied, electronic gaging and segregating methods can be used on automatic machines for accurately checking and sorting parts having dimensional tolerances as small as 0.000020 inch.

Although present electronic inspection methods are enabling us, today, to solve measurement problems which were thought unsolvable only a few years ago and we speak of millionths of an inch rather than thousandths, there are many future developments in methods which will far surpass those we use today. It is also evident that the use of electronic inspection methods for process control will greatly increase.

From a paper entitled "Parts Inspection and Decision Making by Electronics," presented at the 27th semiannual meeting of the American Society of Tool Engineers, St. Louis, October, 1959.

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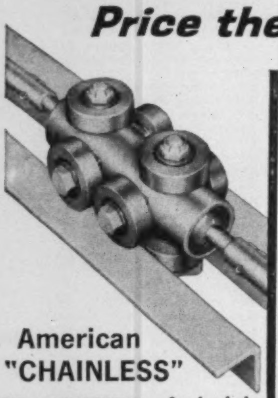
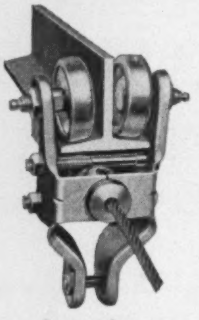
CONVEYORS?

Price these two!



American "CHAINLESS"

NO SPROCKETS! 8-wheeled trolley rolls around curves. Two, three or four-rail track is used on levels, curves or inclines, as needed. Solid steel rods with ball-socket joints connect the trolleys. The in-line drive is ideal for in-the-floor tow-type, pallet or overhead installations. Drive indexes precisely. For loads to 400 lbs. per hanger.



American "CABLE-WAY"

COMPACT! Smallest sprocket is only 15¼" diameter. Four trolley capacities: 80, 125, 160 and 250 lbs. per hanger. Trolley side-plates bolt over factory-positioned drive lug. Track bolts together. Conventional sprocket drive. Smooth, quiet, exceptionally low in price. Ask for Catalog CD-B.

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CONVEYOR DIVISION

THE AMERICAN MONORAIL CO.

Fourth & Franklin Streets • Tipp City 3, Ohio
In Canada: Canadian MonoRail Co. • Galt, Ont.

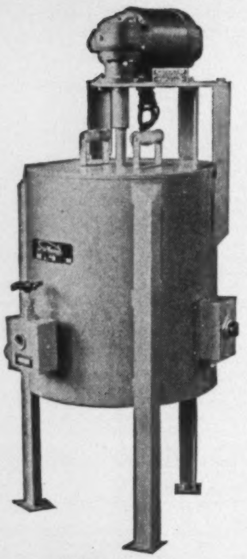
Circle 727 on Page 35

Sta-Warm ELECTRICALLY HEATED

CYLINDRICAL TANKS

for melting and dipping compounds

- Available in wide range of capacities and voltages and with a variety of useful accessories. All designed to fit your production specifications. Sta-Warm Melting Tanks are engineered with or without agitation to supply properly melted compounds economically and efficiently.



52MBW popular 15-gallon tank equipped with power agitator and heated gate valve.

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"If You Can Wrap a String Around It, Sta-Warm Can Heat It for You."

Sta-Warm ELECTRIC CO.

161 N. CHESTNUT ST., RAVENNA, OHIO

Subsidiary of ABRASIVE & METAL PRODUCTS CO.

Circle 728 on Page 35

are you stuck?

confidential file

Readers with problems concerning systems, equipment, or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Readers having solution suggestions are invited to submit them and should refer to case number and title of the problem involved. Dates shown with suggestions indicate issue in which the problem was presented.

CASE 2181-P

SENSING SCORED LINES

. . . I have been unable to find a device for sensing scored lines in glass. If I could find such a device (whether it is based on transmission, reflection, or whatever means) to sense a scored line and further activate automatic breaking machinery, it would solve many of the present problems I am encountering in designing an automatic glass cutting and processing machine. Large stock sheets of glass would be coming down a conveyor line and would be scored automatically. . .

Assistant to Vice President

CASE 2182-P

LOADING HEADED DOWELS

. . . Will you please advise me of the company or companies that I may contact to design and build an automatic loading device. The requirements are that the device automatically load headed dowels of five various lengths into cavity plates with two different hole patterns. . .

Chief Engineer

CASE 2183-P

READING AND RECORDING CAR NUMBERS

. . . The railroad industry is in need of and attempting to find a means of automatically reading and recording car initials and numbers as cars pass certain points or are shuttled in and out of yard tracks. . .

Operations Engineer

CASE 2184-P

MAKING ASBESTOS CIGARETTE FILTERS

. . . I am in the mining industry and have several asbestos properties. I wish to erect a plant with automatic equipment to produce asbestos cigarette filters and one for prefabricated warehouses from asbestos. The above is still in the research stage, but I am currently making definite plans.

President

CASE 2185-P

ELIMINATING RESIDUAL MAGNETISM

. . . As manufacturers of needle rollers, we avoid as much as possible developing residual magnetism in our product. Yet, it does occur, and we would like to have suggestions regarding sources for information on the detection and avoidance of residual magnetism. . .

Chief Engineer

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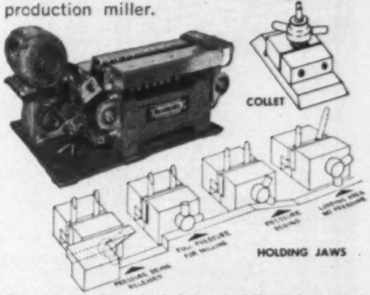
BAIRD

MACHINE 3000 PARTS PER HOUR

AutomaticMILL

AutomaticMILL moves a matched set of hardened holding fixtures or collets through precision locating rails at such variable speeds that 250 to 6000 parts can be machined in a single hour, with machining accuracies duplicated within .001". AutomaticMILL can be clamped to the bed of a horizontal or vertical milling machine, or a milling head can be mounted on the unit to obtain a self contained high speed production miller.



Parts are inserted into holding jaws or collets by hand or by hopper feed. While the bases continually move the parts are locked into position, pass beneath the cutter and are milled. The carrying bases travel beyond the hardened ways and the parts are released.

write for literature or see your BAIRD Distributor

AutomaticMILL inc.
DANBURY INDUSTRIAL PARK • DANBURY, CONN.

Circle 729 on Page 35

CLASSIFIED

ENGINEERS—MECHANICAL—ELECTRICAL

Challenging opportunities in the design and development of Industrial Automation Equipment are available at Aerojet-General Corporation Atlantic Division. Positions offer unusual professional scope for the inventive, imaginative engineer who wishes to become established in a progressive organization with many employee benefits. B.S. degree and 2 to 7 years' experience required.

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Use an Inquiry Card

For further information on anything described or advertised in this issue . . . .

SEE Page 35

Quality metal products deserve

"the finishing touch" of Mahon

FOODSTUFFS
CHEMICAL PRODUCTS
PETROLEUM PRODUCTS
PAINTS

another example . . .

"maximum protection" cargo drums from top U.S. supplier

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YOUR BIGGEST VALUE IS IN MAHON'S PLANNING & ENGINEERING EXPERIENCE

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SQUARE D *announces* NORpak

—A SIMPLER, FASTER, STATIC CONTROL!

12345678910

NORpak is a significant advance in the field of static switching. Like other static systems, **NORpak** performs the functions of machine tool relays, stepping relays, latching relays and timers —all without contacts or motion of any kind.

Like other static systems, **NORpak** is ideal for applications where speed is important—where reliability and long life are essential—where conditions make conventional magnetic devices impractical.

But unlike other static switching systems, NORpak offers these important advantages

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The transistor NOR unit is the basis of **NORpak.** All logic functions—AND, OR, NOT, MEMORY—can be accomplished with combinations of this single NOR unit.

NORpak is *not* complicated — it's easy to apply to conventional circuits. Units are color-coded for quick identification. Simple DC circuit eliminates worry about phase relationships.

UNMATCHED SPEED

NORpak provides switching at rates up to 25,000 per second—faster than any other industrial static system.

SMALLEST COMMERCIAL PACKAGES

NORpak is available in the form of individual components, or in completely engineered systems. Components are offered in 6 and 20 paks, require only 1/4th the equivalent relay panel space, and weigh less than components of other static systems.

EXTRA DEPENDABILITY

NOR units have been time-tested in computer use for years. They are not subject to wear, will give top performance indefinitely, and provide unfailing circuit fidelity.

SIMPLE TO USE

Optional monitor lights give visual evidence of proper performance. Simple dynamic sequence tester checks individual NOR units in operation.

EXPERT APPLICATION HELP

Field specialists, factory-trained in all aspects of **NORpak** can give you on-the-spot answers to any application questions.

NORpak is available as individual components for application to specific control functions, or as completely engineered systems ranging from the smallest to the largest panels

*Write for the complete story on **NORpak** —its theory, application and operation...*
Square D Company, 4041 North Richards St., Milwaukee 12, Wisconsin

D *...design leadership*

SQUARE D COMPANY

wherever electricity is distributed and controlled

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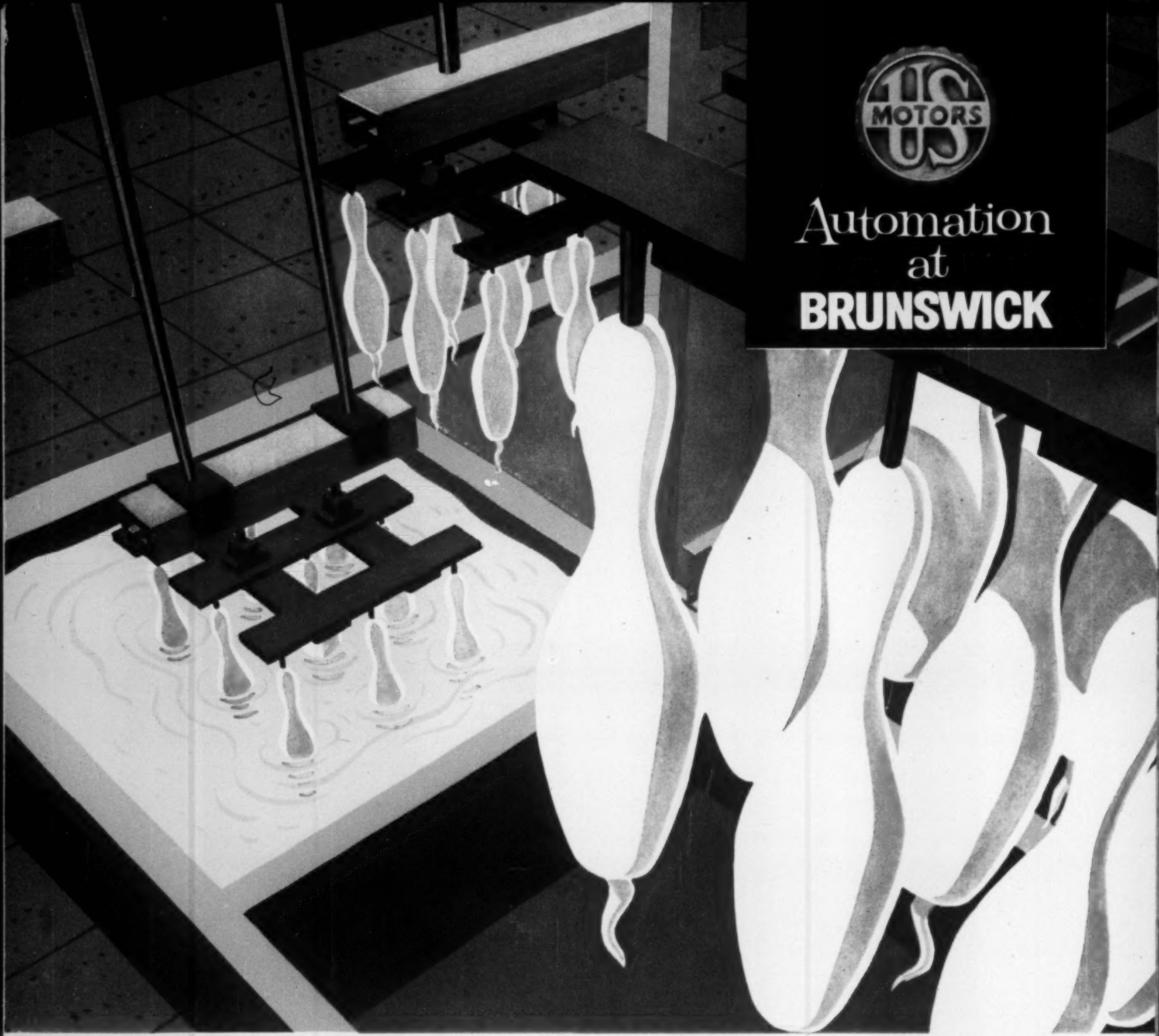
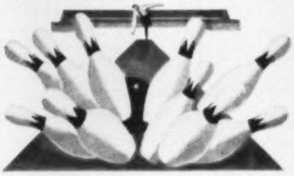


U.S. VARIDYNE system synchronizes conveyors for point-to-point pin transfer



Problem: Brunswick's "Dura-King" pin required multiple dips in liquid plastic to achieve its high impact-resistant plastic coating. Resultant highly explosive atmospheres required *explosion-proof* production methods. In addition, accurate synchronization for point to point transfer between *five* variable speed, multimotor conveyors was required. **Solution:** U.S. VARIDYNE a/c Drive System with *Coordinated Start and Stop Control,* and U.S. Explosion-Proof A.C. Motors. Richards-Wilcox engineers, working with Brunswick Corp. engineers and U.S. MOTORS field engineers, chose VARIDYNE over a d.c. system because: initial start-up is simplified; instantly synchronous without warm-up; needs no synchronizing readjustments; there is no cumulative error; and *explosion-proof a.c. motors* can be used. VARIDYNE varies the frequency of a.c. current to these motors, converting them to adjustable speeds...automatically coordinated. *Write today for* VARIDYNE *Brochure F-1963.*

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